ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XLVI. No. 23.

TABLE OF CONTENTS:

ENGINEERING NEWS OF THE WEEK..... 417
The Montgomery, Alabama, Water Power Plant (illustrated)..... 418
The Position of the Engineer in Municipal Service.. 420
Progress on the Simplon Tunnel and Temperature Observations..... 421
A Pneumatic Tube System of Parcel Distribution in Boston (illustrated)..... 422
Estimating the Cost of Concrete (illustrated)..... 425
Special Local Passenger Service on a Steam Railway to Compete with an Interurban Electric Railway (illustrated)..... 424
Needed Changes in Torpedo Boat Design..... 425
Car Lighting by Acetylene Gas on the Avery Acetylene System (illustrated)..... 426
A Proposed Special Meter Schedule to Charitable, Religious and Educational Institutions in Baltimore..... 426
Operation of the Albany Water Filtration Plant... 427
Telephone Cable in the St. Gotthard Tunnel (illustrated)..... 427
Mechanical Filtration at East Providence, R. I.... 434
Report of the Committee of the New England Water-Works Association on Standard Specifications for Cast-Iron Pipe..... 435
Another British Engineer's Comments on American Dam Design..... 436
Book Reviews..... 437
The American Institute of Mining Engineers in Mexico (continued from p. 406)..... 437
A Carpenter's Suspension Bridge at Shawinigan Falls, P. Q. (illustrated)..... 439
The Efficient Working of Gas Plants for Gas Engines..... 439
A New Form of Bumping Post (illustrated)..... 440
EDITORIAL NOTES..... 428
Recent Feats in Long Distance Electric Power Transmission—High Potential Overhead Wires in Cities—Fixing Water Rates for Charitable Institutions—Engineering and Good Municipal Governments—Concrete as a Facing for Overfall Dams—Experience with Sand Filtration at Albany, N. Y.
EDITORIAL:
Some Things that Didn't Go..... 429
LETTERS TO THE EDITOR..... 429
Formulas for Computing the Frustum of a Pyramid—Why Did this Keystone Drop? (illustrated)—Concerning the Use which the American Society of Civil Engineers Doesn't Make of Its House—"Lever" Ruling Pens and "Duplex" Ruling Pens—Another Diagram for Rivet Spacing (illustrated)—A "Dinner Specification"—A Test of Tetrangles and Double Triangles—Formula and Diagram for Solving Spillway Problems (illustrated)—The Sanitary Protection of the Water Supply of Baltimore, Md. (illustrated)—The Fairhaven Water Tank Failure (illustrated)—The Recent Gathmann Gun Tests (illustrated)—Notes and Queries.

THE PLANS FOR THE NEW BATTLESHIPS and armored cruisers, formulated by the Naval Board on Construction, call for vessels of the following dimensions: For the cruisers, length on load water line, 502 ft.; beam, 78 ft. 8½ ins.; trial displacement, about 14,500 tons; maximum displacement at full load, about 15,960 tons; maximum draft, about 27 ft. 2 ins.; total coal capacity, about 2,000 tons; indicated horse-power, 25,000; trial speed not less than 22 knots. The armament will consist of four 10-in. rifles, sixteen 6-in., twenty-two 3-in., twelve 3-pdr. and fourteen smaller guns. The water-line belt armor would be 7½ ft. wide, with a maximum thickness of 6 ins., tapering to 3 ins. at the ends. The barbettes for the 10-in. gun turrets would be from 7 to 4 ins. thick; the turrets for the 10-in. guns would be 8 ins. thick with 9-in. port plates. The conning tower and its shield would be 9 ins. thick. Each vessel would carry 864 officers and men. The plans for the new battleships, as fixed by this board, make these vessels 450 ft. long, 76 ft. 8 ins. beam, 26 ft. 9 ins. maximum draft, 17,604 tons maximum displacement. They would carry 2,200 tons of coal, have 16,500 I. HP., and a trial speed of not less than 18 knots. The battery will consist of four 12-in. guns, eight 8-in., twelve 7-in., twenty 3-in., twelve 3-pdrs. and eighteen smaller guns. The armor belt would be 3 ft. 3 ins. wide, and be 11 ins. thick tapering to 4 ins. at the stem and stern. The 12-in. barbettes would be 10 ins. thick, with turrets 9 ins. thick, and 11-in. port-plates. The crew would include 797 officers and men. The board decides against sheathing, admitting that while this sheathing and coppering are partial protections against fouling, there are decided disadvantages in sheathing, and that under ordinary conditions the bottoms of these ships can be kept sufficiently clean by the use of anti-corrosive and anti-fouling paints. The board approves of the elliptical balanced turret, with inclined port-plates, as the best form. Torpedo-tubes on heavy armored vessels not recommended, the board believing that torpedo warfare should be left to torpedo boats and to smaller cruisers. The 7-in. gun proposed does not yet exist in our navy in an acceptable and tried form, but can soon be provided.

THE NORTH-GERMAN LLOYD steamship "Kronprinz Wilhelm," reached New York, on Nov. 26, in 5 days, 19 hours and 6 minutes, sailing from Cherbourg, over a course of 3,049 miles. This is 2 hours and 6 minutes better than her previous best record; but it does not touch the record of the "Deutschland," which ship made the same trip in August last, in 5 days 12 hours and 23 minutes. The "Kronprinz Wilhelm," however, had heavy weather nearly all the way across, with two days of a fierce gale from the southeast.

THE ECONOMY OF LARGE SCHOONERS, now generally used in the coasting trade, is thus figured out by Mr. Frank N. Tandy, a general marine agent of Boston, Mass.: The first schooner on his list cost $72,000, had a gross tonnage of 1,804, and her carrying capacity was 3,000 tons. This vessel consumed 512 days in making 12 voyages, and in this time paid dividends amounting to 38.8% of the cost of the ship. The average of a fleet of two 4-masters and two 5-masters was a yearly profit of 27.5% on the investment; with average net earnings of 42.9% of the gross receipts, and 18.9% of the total cost of the vessels paid in one year.

BIDS FOR GARBAGE COLLECTION AND DISPOSAL at Cincinnati, O., for five years from June 1, 1902, and for the collection and disposal of dead animals and animal offal from July 3, 1903, to June 1, 1907, are to be received on Dec. 11. All bids must be sent to the Committee on Health, Board of Legislation, care of Edwin Henderson, City Clerk. Specifications may be secured from Mr. Henderson. The garbage of Cincinnati is now being treated by the Simonin reduction process, as described in Engineering News of Oct. 8, 1896, and April 26, 1900.

THE FRANCHISE OF THE NEW ORLEANS WATER-Works Co. has been declared forfeited by the State Supreme Court for non-fulfilment of its terms. The specific count made in the ruling of the court was wilful and persistent charging of water rates in excess of the franchise stipulations, but in the opinion handed down by the court the latter seemed to be convinced that the company had utterly failed to supply water of a proper character. Mr. Frank T. Howard has been appointed receiver of the company. The company has asked for a rehearing. The city of New Orleans is one of the chief stockholders in the company, but has only a minority representation on the board of directors. The city intends to establish a water-works system under full municipal ownership and control.

ASPHALT PAVING REPAIRS AT ST. LOUIS, MO., are to be made by contract for the next ten years, instead of by the city, if a recent city ordinance is approved by the mayor. Our attention has been called to an article in the St. Louis "Globe-Democrat" for Nov. 30, containing arguments against the abandonment of the municipal repair plant. It is claimed that the proposed contract, by limiting the asphalt to be used in repairs to Trinidad Lake, Bermudez and Buena Vista virtually prohibits all competition. It is urged that the city can do the repair work at a much lower figure than will result from the proposed change, but that the difference in cost will not be so great if competition is allowed.

BIDS FOR GAS AND ELECTRIC LIGHTING in Greater New York during the year 1902 will be received on Dec. 11 by Henry S. Kearney, Commissioner of Public Buildings, Lighting and Supplies. The contracts will cover all public lighting in the five boroughs.

THE NEW WASHINGTON AQUEDUCT TUNNEL, according to reports, was put in operation on Nov. 24. The tunnel was begun late in 1883, or early in 1884. After construction had been in progress for some five years, and had been well advanced towards completion, the tunnel was abandoned on account of faulty construction. Two reports on completing the work were subsequently made, abstracts of which will be found in our issues of May 4 and 11, 1889, and Feb. 20, 1896. It is in accordance with the recommendations of the latter report that the tunnel has at last been completed. An illustrated description of the various methods of repair employed was given in our issue of Dec. 28, 1898.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a butting collision on the Wabash Ry., near Seneca, Mich., on the evening of Nov. 27. Train No. 4, east bound for Detroit, while running at a rate of 50 miles an hour, ran into No. 13, which was running west at a slower rate. The latter train was almost totally destroyed, the other being also badly wrecked; the ruins took fire immediately after and burned so fiercely as to prevent for a time all work of rescue. The killed number, according to different accounts, from 20 to over 50, while probably over 100 were injured. Train No. 13, a double header, consisted of one baggage car, two day coaches and two Pullmans. In the day coaches were crowded a large number of Italian immigrants. It was in these two cars, said to be old and light cars, penned between the two engines and the two Pullmans, that the larger part of the mortality occurred. What appears up to the present to have been the cause of the disaster is the misreading by the engineer of No. 4 of orders issued to him at Montpelier, O. The train order, a copy of which was also given to No. 13, read:

"Order No. 32—No. 4, engine No. 600, will meet No. 13 at Seneca, and No. 3, engine No. 623, at Sand Creek; engines No. 88 and 151 will double head No. 13."

The engineer of No. 4 read this to mean that he was to pass No. 13 at Sand Creek. The collision took place on a section of straight track, and though the engineer saw No. 13 while yet several miles off, he was deceived by its electric headlight and thought it was waiting at Sand Creek.

A GAS EXPLOSION in the conductor-rail conduit of the Metropolitan Street Ry. in New York on Nov. 28 tied up all the surface lines in the lower half of the borough of Manhattan for almost 24 hours. A broken gas main near Bowling Green had allowed a larger quantity of gas to escape into the conduit, and when a spark from the collector shoe of a passing car ignited the gas the covers of manholes and insulator boxes for the space of more than a block were blown into the air. The burning gas destroyed the insulation of a group of five feed cables, breaking the circuit at the sub-station in Front St. and interrupting all street-car traffic below Houston St. By the morning of Nov. 29 the damage had not yet been repaired and considerable delay was caused to the crowds of people who use the surface cars to reach their places of business.

A BOILER EXPLOSION wrought exceptional havoc at the plant of the Penberthy Injector Co., Detroit, Mich., on Nov. 26. A three-story brick building on the ground floor of which the boiler room was located was blown up by the explosion of one of the boilers. Of the eighty or ninety people in the building at the time of the explosion, over a score were killed and many more were injured by the collapse of the structure and the burning of the ruins.

EXEMPTION FROM FIREPROOF CONSTRUCTION has been granted by the Department of Buildings of New York city in the plans for the tall office buildings at Broadway and Maiden Lane, and at Broadway and 23d St., and an investigation, with a view to legal action, has been set on foot by a number of builders and architects. The section of the law which has been violated is the one requiring that in all buildings over 150 ft. in height all material used shall be fireproof. In the buildings in question ordinary wood is being used where metal or fireproof material are required by the building code, and the investigation being made has shown that the Building Department has assumed to grant permission for this violation of the code. In an interview to the newspapers, Mr. A. S. Gilbert, of the law firm of Gilbert & Mayer, which has been retained to make the investigation, discusses the action of the Building Department as follows:

The Board of Buildings has no right to grant such exemptions, and they plainly exceeded their authority in doing so. The only power that the Board of Buildings has in the Borough of Manhattan and the Bronx is defined in Section 650 of the charter. This section provides that the Commissioner of Buildings shall be empowered, with the approval of the board, to vary or modify any rule, law, or ordinance relating to buildings, only in case there are practical difficulties in the way of carrying out the strict letter of the law, so that the spirit of the law shall be observed and public safety, security and substantial justice done. Neither in the papers filed in the Building Department nor as a matter of fact has it at any time been shown that there are such practical difficulties in the way of complying with the building laws on the structures referred to. Section 105 was enacted for the purpose of using every possible precaution against and in the event of fire, and these exemptions allow the use of ordinary wood where either metal or fireproof material should have been used. These builders have practically set aside certain provisions of the building laws.

THE FIRST CABLE WIRE of the New East River Bridge at New York city was spun across the river on Nov. 27. A large amount of wire is now on the ground and it is expected that the cable construction will progress rapidly from this time on.

A RESERVOIR FAILED AT PITTSTON, PA., on the morning of Nov. 28, by being filled, by pumping, to overflowing. The structure was built by the Pennsylvania Coal Co. about thirty years ago, and is now owned by the Erie Railroad Co. The reservoir when full held about 4,000,000 gallons. It was in the form of a parabola, with a base of about 200 ft. and an axis or length of about 300 ft., both measured at the top of the slope or at the water's edge when full. The depth from the bottom of the reservoir to the top of the bank was 16 ft. About one-half of the perimeter is formed by natural banks of the hillside and the other half, including the base, by a bank composed of earth only. The inner slope of the bank is 2 to 1 and the outer slope 1½ to 1. The inner slope was roughly paved with cobble stones. There was no overflow pipe and the failure was caused by the water overflowing the bank at the right corner of the base and gradually washing away about 30 ft. of the bank. The reservoir was drained in about two hours and no damage was done beyond the filling of four or five cellars with water. Had the break occurred in the middle of the base much damage would have been done to the city of Pittston. For this account of the failure we are indebted to Mr. John W. Berry, Consulting Engineer, Pittston, Pa.

THE MONTGOMERY, ALABAMA, WATER POWER PLANT.

One of the greatest water power and electrical plants in the South is now being installed by the Montgomery Water Power Co. on the Tallapoosa River, 30 miles from Montgomery, Ala. The improvement consists of a dam across the Tallapoosa River at a point three miles above Tallassee, Ala., for the purpose of generating 5,000 HP. and then transmitting this power electrically to Montgomery, where it is to be used for lighting and power purposes. The minimum low water flow of the river at this dam is from 1,100 to 1,200 cu. ft. per second, and the fall is 40 ft. Storage is secured to supplement the low water flow.

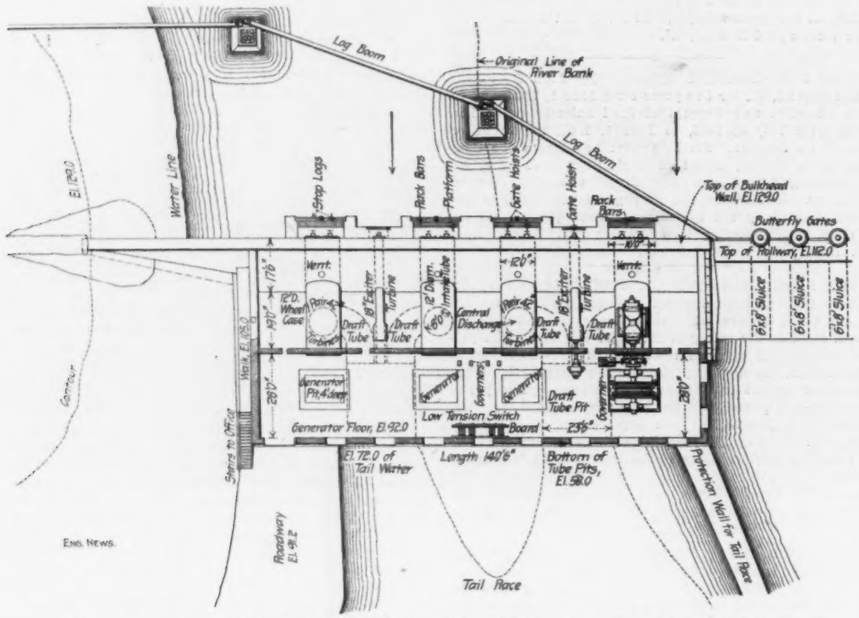


FIG. 1. GENERAL PLAN OF POWER HOUSE, MONTGOMERY WATER-POWER PLANT.

The site for this magnificent enterprise was originally secured by H. C. Jones, of Montgomery, and sold by him to Emerson McMillin & Co., of 40 Wall St., New York city, for development. The engineering, contracting and constructing of the entire plant was placed in the hands of the International Hydraulic Co., of 40 Wall St., New York city, of which Mr. J. M. McCarthy, C. E., is the General Manager, and Ethan Philbrick, Engineer.

The preliminary surveys and the obtaining of the necessary data for making the plans for the improvement was started in the latter part of March, 1899, under the personal direction of Ethan Philbrick, engineer for the company. The plans were all completed by him and his assistants in every detail by July 1, when the contracts were consummated for doing the necessary construction work and furnishing the proper machinery. The construction work was started the latter part of July, and has been continuously prosecuted since. The hydraulic work, under the direction of the engineer of the company, is now well along toward completion. There has been erected across the bed of the river a solid granite masonry dam averaging 42 ft. in height, built upon a bedrock of granite.

The dam is built in a curve with a radius of 3,820 ft. The thickness of the dam at the top is 7 ft. and at the bottom 39 ft. The spillway is 640 ft. long and the bulkhead wall 210 ft., making a total length of dam of 850 ft. The top of the bulkhead wall is 17 ft. above the crest of the dam and protects the power house from floods and high waters. The storage basin or reservoir averages half a mile wide and seven miles long and from 10 to 60 ft. deep.

Through the base of the dam proper, near the end next to the power house, are three openings, 6 × 8 ft., into which cast-iron sluice gates of the butterfly pattern are placed. These gates are fastened or hung vertically through the center by a 4-in. diameter hammered iron shaft, which extends to the gate rigging on the crest of the dam. The gates, being nearly balanced by the water pressure, are readily operated by one man.

The bulkhead wall forms the up-stream wall of the power house, and extends 4 ft. above the roof of the power house, the top of the wall being covered and protected by a granite coping. In front of the bulkhead wall cutstone buttresses were built, so that on each side of each penstock or intake tube the buttresses extend out 7 ft. from the face of the bulkhead wall. Between these buttresses and up against the bulkhead wall the head gates are placed, separating the water in the reservoir or open forebay from the intake tubes. In front of the head gates come the rack bar frames, and onto these are fastened the rack made up of ½ × 3-in. iron bars, placed on edge to arrest or catch any brush, sticks or foreign matter. The bars are inclined backwards towards the top to facilitate the removal of rubbish. In front of the rack bars are placed stop logs, so that the water may be shut off outside of the line of the gates and rack bars to facilitate repairs in case any injury happens to the rack bars or gates. Considerable skill and ingenuity was displayed by the engineer in this arrangement, and it differs from any other plant now built.

The gates to close each of the 12-ft. penstocks are divided into two parts, which slide vertically between channel irons. The stop logs outside of the rack bars close the 16-ft. wide opening by two 8-ft. lengths sliding in channel irons, anchored into rabbets cut in the buttresses. The penstocks are of ⅜-in. boiler steel, and extend through the bulkhead wall in the form of thimbles, and also form a portion of the wheel cases. The full length of the penstock and wheel case combined is 39 ft.

The plant is designed and built for four units, each unit composed of two 42-in. McCormick turbines, revolving on a horizontal shaft. The elevation of the shaft is 16 ft. below the crest of the dam and 24 ft. above tail water, so that three-fifths of the head is below the center of the wheel, and with a seven-eighths gate opening the wheels are guaranteed to give not less than 82% efficiency.

The object in placing the wheels at this elevation was to insure the generator floor and pits being always above flood water level.

The draft tubes are of ½-in. boiler steel; the top ends are 8 ft. in diameter and the outlet end 9½ ft. The top end is riveted to the cradle or cast-iron base, on which the camel's-back or casting which contains the wheels rests. The tubes extend downwards and also sideways 12 ft. and forward 16 ft., making a somewhat curved tube 38 ft. long, which then discharges h[illegible]ally into an arched tube pit beneath the fl[illegible] the generator room. The object in curving [illegible]bes was so as to allow piers to be built to [illegible] the generators upon. The tube pits, which [illegible] 4 ft. long, 26 ft. wide and 30 ft. deep under [illegible]ddle of the arch, extend from the lower en[illegible] the draft tubes to the south wall of the po[illegible]use and there discharge into an open tailra[illegible]

DAM.

In the construction of the dam we fin[illegible]ces of masonry which certainly seems to [illegible] the conditions for which it was intended. [illegible] shows section of dam as built.

The first object to be secured in building [illegible]am is to provide sufficient weight to resist th[illegible]ces of the water impounded; second, to so [illegible]uct the dam as to prevent leaks or seepag[illegible] The dam was built of a very hard and durable [illegible]ite, mostly quarried from the bed of the riv[illegible] and the stone used were of the largest possible [illegible]ensions, some requiring two steam derricks [illegible]place them in position and weighing from 9 to [illegible]ons. The up-stream and down-stream faces of [illegible] dam were laid very carefully with cement mortar [illegible]beds and joints, the up-stream face being laid [illegible] with Portland cement. In the central portion [illegible] the dam very large rough stone were fitted [illegible]ther and all spaces filled with smaller stone, then packed with spalls, so as to form as nearly as possible a solid mass of rock without mortar. After building up this material for 5 or 6 ft., grouting boxes were placed upon the wall and the spaces between the spalls were entirely filled with liquid cement, thereby insuring all horizontal and vertical joints being entirely filled and cementing the entire dam into one solid mass. By using this method of construction the weight of the structure has been increased about 10% over what it would be if laid up with mortar joints, and the cost of construction has also been decreased by using less cement. All liability is avoided of leaks from imperfectly fitted mortar joints, which certainly would have resulted from the use of rough rubble stone laid up in mortar.

To furnish a perfectly smooth surface for the water to pass over and to obviate the shaping of the face stones to a batter, a layer of Portland cement concrete averaging 2 ft. in thickness extends from the upper side or back of the dam at the crest over the crest in a curved surface and down to the foot of the down-stream side or face of the dam.

The concrete forms were held in place by means of iron rods built into the masonry while building the dam. The batter of the down-stream face of the stonework under the concrete was formed by stepping back as the wall was built, and was left as rough as convenient to form a better surface for the adhesion of the concrete.

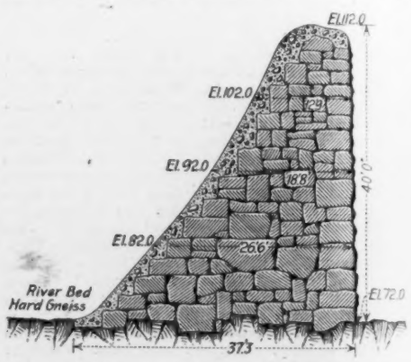


Fig. 2. Section of Dam across Tallapoosa River.

POWER HOUSE.

The walls of the power house on three sides above the generator floor are of brick; the roof is of iron and steel. Everything else is of heavy stonework. The building is 140 ft. long, 65 ft. wide and 64 ft. high above the bottom of the tube pits. The generator room is 30 × 138 ft. and 28 ft. high, well lighted and ventilated by 13 windows, 6 × 10 ft. The floor is of Portland cement, laid over the solid masonry and concrete foundations.

The wheel case room is situated between the generator room and the bulkhead wall, and is

separated from the generator room by a brick partition wall extending the full length of the building and from the generator floor to the roof. Above the wheel case room are four rooms; one for the transformers and high-tension switchboard is located in the central portion of the building. At the west end, next to the shore, is the office room, 24 × 30 ft., well lighted by two gate gearing and rigging is placed outside of the wheel cases and in the generator room where the governors are located. The wheels discharge centrally into an 8-ft. draft tube, the draft tube being 8 ft. at the top end and 9½ ft. at the discharge. The entire length of the tube is embedded in masonry and concrete, as all portions of the building under the first floor except the two tube pits is a solid mass of masonry and bedrock. In addition to the four pairs of main wheels, there are two 18-in. single McCormick wheels used to drive two exciters. All of the wheels are directly connected with the generators by means of flexible insulated couplings with leather links.

FIG. 4. A VIEW DURING CONSTRUCTION.

end windows and two skylights. In the room at the east end of the building are located the lightning arresters; the other room is used as a storeroom. In the generator room is a 30,000-lb. hand-power traveling crane, which can be used the entire length of the building.

WATER WHEELS.

The turbine wheels are of the McCormick pattern and manufactured by the S. Morgan Smith Co., of York, Pa. There are four pairs of 42-in. wheels placed upon horizontal shafts, and each pair developing 1,250 HP. at generator shaft under a 37-ft. head, running 200 revolutions per minute. The wheels are enclosed in steel wheel cases, and receive their water directly from the forebay through intake tubes 12 ft. in diameter and about 15 ft. long. The flow of water through the wheels is regulated by means of gates operated by the Lombard water-wheel governors. All

ELECTRICAL MACHINERY.

The electrical generators are 875 K-W. Stanley machines of the alternating current three-phase type, working with a frequency of 60 cycles per second, and manufactured by the Stanley Mfg. Co., of Pittsfield, Mass. The generators have a velocity of 200 revolutions per minute and a normal potential of 2,000 volts. The base of the generators rest upon 18 × 24-in. oak bed timbers, which, after framing, were boiled in paraffine to give a good insulation. The bed timbers are all bedded in concrete, which comes up level with the base of the generators. The generator switchboard is located in the center of the generator room and on the floor level. The rheostats are placed over the switchboard and supported by the switchboard frame and operated by means of sprocket chains.

In the center of the building, over the wheel case room, are the transformers and high and low tension switchboards. The transformers, three for each generator, are capable of raising the voltage to 30,000 volts from the 2,000 as it comes from the generators. The current is then carried to Montgomery at the high voltage over six hard-drawn No. 5 copper wires, using an insulated wire within the city limits.

The transmission lines are supported upon Bock triple-petticoated porcelain insulators, fastened by locust pins to 6 × 8-in. Georgia pine cross-arms. The line is a little less than 30 miles long.

DISTRIBUTION SYSTEM IN MONTGOMERY.

In case of an accident to the transmission lines, or from any cause, any interruption at the water power plant, a steam engine equipment of 2,000 HP. has been provided in Montgomery which will provide for all lighting, street railway and small power business, so as to avoid inconveniencing the public. The dynamo and engine room here is 127 × 56 ft., with an addition to take care of the high-tension apparatus. Here there are eight Stanley transformers of 382 K-W. capacity, stepping down from 27,000 volts to 2,300 volts and changing from the three-phase to two-phase system. There are also synchronous motors, which will be run as alternating current generators in case of interruption on transmission line or at water power plant. The city is being divided into six circuits, fed by separate sets of primaries. The city is capable of furnishing a large power business, which this company, with its latest and best improvements in electric power line, is amply able to take care of, as has been evidenced by its numerous power plants throughout the country, owned and operated by Emerson, McMillin & Co. The International Hydraulic Co. has several other plants under way which may even outdo this one when they are completed.

THE IRRIGATION OF ARID LANDS in the United States forms an important part of the annual report of Secretary of the Interior Hitchcock. The Geological Survey, as the result of a special examination, reports that one-third of the area of the United States is still vacant, mainly on account of the lack of irrigation for this 600,000,000 acres. The Secretary points out that it is imperative to adopt at an early date some definite policy leading to the best use of these now vacant lands; he recommends a system of reservoirs and canals, built by the government on properties where known good results will follow. Among such places he names the San Carlos region; the construction of reservoirs in the Sierra Nevada, in California, to reclaim what is now desert land, and the diversion of the St. Mary River into the headwaters of the Milk River in Montana.

FIG. 3. THE DAM SITE AT STARTING OF WORK.

FIG. 6. VIEW OF THE FOREBAY.

THE POSITION OF THE ENGINEER IN MUNICIPAL SERVICE.*

By Alex. Dow,† M. Am. Inst. Elec. E.

You will find my text in the Detroit "Evening News" of April 5, where one of the Public Lighting Commissioners is quoted as saying:

I used to think that municipal ownership was a good thing, but my experience has taught me that it is impossible to divorce public business from politics. It is all

FIG. 5. HIGH WATER DURING CONSTRUCTION.

politics, and just now the Public Lighting Commission is composed of two Republicans and four Democrats.

My experience is different from that of the commissioner quoted. It has taught me that it is entirely possible to keep public business separate from politics, even the public business of that very commission. My experience has led me to believe it possible to divorce public business from politics after the two have formed such an unholy alliance. To keep them separate in the beginning was the work of an engineer, and I now propose to tell how it was done.

The first Lighting Commission was absolutely non-partisan. In its constitution there was the usual recognition of each of the great parties, but each of those six men stood for the whole city and never for a moment for his own political friends. That was as it should be. A bi-partisan board is not a non-partisan board. You cannot neutralize three aggressive Republicans by appointing three equally aggressive Democrats. Two blacks don't make one white, and the result in practice is at best a deadlock. If by any chance a Republican partisan votes with the Democrats, he is called a traitor, and there is a howl for his political scalp.

This non-partisan commission decided that its duties were essentially legislative. Its members were business men who certainly could not give attention to details of commission work. You remember that these commissioners are unpaid—well, perhaps I should not put it so, but the payment they get is of the kind best described by a tale concerning our fellow-member, Mr. Frank E. Kirby, who served a term as a Water Commissioner of this city. The Water Board of a large eastern city visited Detroit in the course of a tour in search of information. Mr. Kirby dropped his other duties to entertain the visitors, one of whom in conversation spoke as follows: "In our city there are three water commissioners; we each get $3,000 a year. How many are there of you in Detroit, and what do you get?" The answer was grim, but precise, "There are five of us, and we get hell." The first Lighting Commissioners were well paid in the coin named by Mr. Kirby. Some of them are, I think, still receiving small instalments of their salary.

Be that as it may, they decided that their duties were legislative, and therein they made a wise decision. They sought as their executive an experienced electrical engineer of good administrative ability. They failed to be satisfied by any of the numerous applicants who asked for the position; they made guarded inquiries concerning a number of men who were engaged in such work as they had to do, and they ended by offering the appointment to a man who was about as thoroughly surprised as any one could be by such an offer. That was me.

From the beginning, the separation of legislative and executive functions was complete. The commission decided on a policy. I reported on and advised as to possible plans whereby that policy could be carried out. The commission authorized the execution of a general plan presented by me, and then it became my duty to carry out that plan, myself selecting the immediate agents and settling the details. On me lay the responsibility for results. Logically to me was given the choice of means.

Given full charge of the work and the force; given power to employ and discharge help; ordered positively to see that each employe earned his pay; to require no qualifications other than citizenship and competence; to disregard all indorsements which were not supported by my own observation of the work actually done for the commission, it would appear that I should have been able to keep practical politicians out of the service of the Public Lighting Commission. Did I do so? Well, I think I did. I was convinced of it by the fact that the Republican politicians of the city condemned me for a Democrat, and the Democratic politicians cursed me for a Republican.

I began, so far as the laborers and mechanics were concerned, at the top of the long list, which was arranged according to priority of application. I called for these men in bunches, sized them up personally after the fashion of all engineers who have to hire men. I questioned them as to their citizenship and previous experience, rated them according to their claims and set them to work. I personally hired each man, and this was a big part of my work. In a short time I could tell whether or not a man was competent. If he showed himself such he remained in the service. Some of those employed in this way seven or eight years ago are still on the Public Lighting Commission's payroll. If a man showed himself incompetent, he was summarily discharged. The orders of the commission were that no man should have a time appointment; that each man should be hired from day to day or from month to month.

There was an application blank which had space for name and address, trade or profession, previous experience and references. The references were often telegraphic. The rule that a man should be a citizen and a bona fide resident of Detroit led to many of the applicants establishing their status by presenting the signature of one of the aldermen of their ward or some other well-known Detroit man. Our foreign-born residents almost always secured the alderman's signature before presenting their application.

Some of the poorest specimens of mankind that were tried in the service brought the most magnificent indorsements from preachers and from pillars of church. I honestly believe the average preacher does not know the making of a decent workman. I must expressly except the Catholic priesthood from this reproach. I noticed that a man who referred us to his parish priest was almost always a good find. On the other hand, some of the best men whom I found, including men who are still employed by the commission, carried the indorsements of politicians whose reputations are far from saintly. I don't say that a tough alderman invariably recommended a good man for a job; what I mean to say is that, especially in these years of business depression, the tough alderman could and did furnish from among their constituents enough machanics and tradesmen, of a thoroughly reliable character, to fill any number of positions such as I had to offer. Of course the tough aldermen sometimes sent worthless men to me, but I had an effective method of dealing with such cases. If the man proved worthless, I summarily discharged him, and then I did not wait for his political sponsor to come to me complaining that his man had been "thrown down." I made the announcement myself to the sponsor, and followed it up by a few well-chosen remarks in the vernacular which let him understand that it was his business to know that a man was a good, capable worker before he sent him down to the Public Lighting Commission, and that if the said sponsor did not know any better than to send such a damnable specimen as the one just discharged I would decline hereafter to consider any of his recommendations.

I commend this prescription to any of you who may find yourselves in such a position as I then was in. The first dose, if liberal, effects a complete cure.

The steam engineers and similar expert mechanics were selected from the list of applicants. In these classes the plan of putting a man to work and seeing what would happen could not be tried with the same freedom as was permissible with laborers. An incompetent engineer might wreck an engine in demonstrating his incompetence; or an unskilled electrician send himself to paradise by the electric route, and thereby cost the city $5,000 or so. It is really remarkable how valuable such a man becomes after he is dead. But the method was modified only in degree, not in kind. A man was first questioned and then tried. His indorsements counted for nothing, his politics for less than nothing.

The relations of the plant to what is called "union labor" were very early defined. The first commission announced that it recognized citizenship and competence

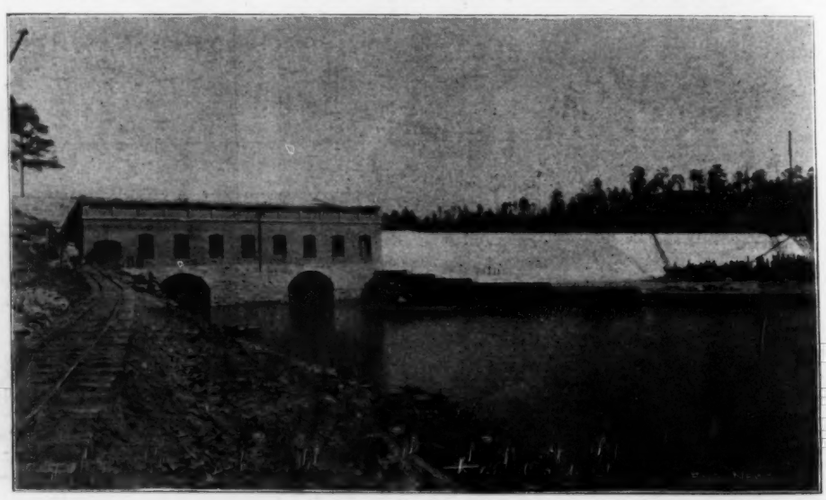


FIG. 7. THE TAIL RACE.

*Extracts from Presidential Address before the Detroit Engineering Society, and published in the "Journal of the Association of Engineering Societies" for October.

†Manager Edison Illuminating Co., Detroit, Mich.

as being the only essentials for employment. It classed union labor affiliations together with politics and religion, as being immaterial so long as they did not interfere with the performance of a man's duties. It resulted that we made no inquiry as to a man's being union or non-union, but that naturally a large proportion of the men employed were union men. I think the ground taken in the matter was solid, and that it is the only ground which promises permanent freedom from trouble.

It was not sufficient to obtain employes who were free from political obligations. It was necessary that they should remain clear of such entanglements. Our rule in the beginning was clearly stated, and it was reiterated from time to time as occasion required. It was that every employe should have opportunity to vote at primary and regular elections; that there should be no inquiry as to how or for whom he voted, but that no employe should on any pretense engage in what is called party work. A report that an employe was making himself notable in politics caused him at once to be called on the carpet and notified that a persistence in such activity would surely lead to his dismissal. In the early days of the commission it was necessary, in more than one case, to warn men individually of the consequence which would follow their persistence in political activity. These warnings took the form of a statement that the Public Lighting Commission was non-partisan; that the retention on the roll of an active partisan of either party would lead to demands from the other party that some equally active partisan of that party should be employed; that the commission did not propose to engage in any such balancing of evils, and that therefore the employe must limit his activities or quit the service.

No man was ever discharged for political activity. Anonymous charges were occasionally made that men were discharged because of their politics, but the record was easily cleared. These charges were all made in the early days, when each party said I was a vile tool of the other party.

For five years—three years of my service and two years of my successor's term—the relations of the commission to its electrical engineer were unchanged. You will recognize that these relations were essentially those of a board of directors of a corporation to their general manager. In my own case they were exactly the relations which I now hold to the directors of the corporations whose property I manage. They were the relations which exist in every such department in every city whose work is well done and free from political taint.

In Canadian cities the man in charge of public works is usually a civil engineer, and he is actually in charge. The Public Works Committee has legislative functions only, and a law duly enacted, not merely a ruling of a commission, prohibits the activity of any city employe in politics.

I have spoken of the successful operation of the public lighting plant while the functions of the commission and the engineer remained clearly defined. It is now in order to tell what happened when this definition became hazy. After five years' operation of the plant, ill-advised economies, insisted upon by the board in direct opposition to the advice of the engineer, caused a strike of the arc lamp trimmers. The question of detail was whether the trimmers did or did not do enough work for their pay; whether, in fact, their duties were proportionate to their wages; whether they had what in the newspaper discussion at the time was called a "snap." I think the trimmers' duties were no snap, and I know whereof I speak. A man who trims sixty open lamps on a circuit of average length daily, Sundays included, summer and winter, in fair weather and in foul, in the early hours of the summer morning and in the bitter sleet storms of our winter and early spring, has no snap if he does his work properly. Electrical Engineer Steele told the commissioners this. They overruled him. Be this minor fact as it may, the major fact was that the commission, to secure a small economy of operation, overruled its executive officer and ruined the discipline of the plant. The damage to the commission, directly and indirectly, by the loss of discipline from that day to this, by the loss of capable employes and the expense of educating others, has offset many times the saving which was expected to be made. The commission assumed control of details which, even had it been competent to judge, it could not personally oversee, and deliberately permitted employes to feel that they had a grievance.

The engineer did his best. He won the strike for the commission, feeling that his duty to the city overrode his sympathy for the men; but thereafter he avoided responsibility, knowing that he could not depend on the support of his directors, and the clamor raised by the aggrieved employes had its unavoidable result. The appointing power, the mayor of the city, tried to remedy the harm done by nominating a commissioner who undertook to specially represent these employes, and who entered on his duties with a prejudice against his associates. This appointment was followed by another; this second nominee frankly declaring himself the special representative of organized labor. Partisans both of them, these commissioners; well meaning, no doubt, but limited in their action by the circumstances of their appointment, carrying to their duties not a receptive mind, but a preconceived hostility to the past management. At meetings of the board charges and countercharges, criticisms and squabbles took the place of frank discussion and of willing submission to the decision of the majority. Tale-bearing by employes was encouraged, different members assuming the protection of different employes or cliques of employes. Matters of detail took up the time of the board, and business was impossible. The plant kept on going from sheer inertia, but the engineer very early concluded that he should end his connection with the institution. He had been wiser for himself, I think, had he come to this conclusion a year soon than he did; but he, like almost all engineers, was faithful to his salt and tried to do the best for his masters, the public, under adverse circumstances.

My conclusion is that a public works department can be operated efficiently and economically on the same lines as is the service of a private corporation; the commissioners assuming the duties of the directorate of such a corporation and the general superintendent, who must be a thorough competent engineer, performing all the executive duties. I can admit no exception to this rule. I am aware that in some organizations the peculiar knowledge of individual directors makes their advice exceedingly valuable in the executive department. This was the case in the first Public Lighting Commission of the city of Detroit. Of that commission, there was not one man who had not a general knowledge of the apparatus and methods involved in the electric lighting business; three of these had served as directors of electric lighting enterprises. The factory of one was a pioneer in the use of electric power distribution, and the commissioner who knew the least of electrical affairs was surprisingly familiar with the routine and costs of a model street railway plant in which he had an interest. Two of the members had technical knowledge and ability which brought them, in the course of their business, a large recompense, and which they gave freely to the service of the city of Detroit. One of these men had been a pioneer in telephone, electric light and electric railway developments, and he is now an officer and director of one of the largest telephone companies in the Middle West. The other, whom I may name, seeing that he is dead, Mr. George Howard Lothrop, was reputed the best authority on electrical patents west of the city of New York. The advice of these men was constantly sought by me as the executive officer of the Public Lighting Commission, and it was always freely given and always valuable. I have indicated sufficiently the peculiar fitness of the first Lighting Commissioners of this city to take charge of detail and to perform the executive duties of their department, and yet it was these commissioners, who knew exactly what they were doing and who were, without exception, better fitted for their public work than any of their successors have ever been, who positively declined to depart from their legislative functions and who insisted upon the assumption by their general superintendent and engineer of the full responsibility and the full authority which his executive duties required. It has remained to men of less knowledge to initiate the contrary policy and to fail in it.

PROGRESS ON THE SIMPLON TUNNEL AND TEMPERATURE OBSERVATIONS.

Work on the Simplon Tunnel up to September 30, 1901, has progressed, in the north or Brieg heading, 18,804 ft., in the south or Isella heading, 14,422 ft., a total of 33,226 ft. out of a finished length of tunnel of 64,718 ft. The total advance during the month of September was 1,141 ft. The average daily advance was 19.6 ft. for the north heading, and 18.5 ft. for the south heading, both using machine drills. The average number of men employed has been about the same as previously, 3,277 being employed on the work during September, as against an average of 3,236 during the year ending July 1, 1901. The geological aspects of the work have undergone some changes. Up to 15,200 ft., the north heading was in crystalline, calcareous slate; at that point a more micaceous, slaty rock, containing an abundance af granitic particles was encountered. A little further on the tunnel passed into a white marble, and still a little farther on a fine-grained white gneiss was reached, which soon passed over again into crystalline slate rock. The south end of the tunnel has from the beginning advanced mainly through an extremely hard antigorio gneiss, whose resisting qualities greatly retarded progress. At about the 14,200-ft. point, this rock gave place to crystalline limestone, which was not expected for some time. The change greatly facilitated advance, but justified expectation of increased quantities of water. After some 200 ft. of marble, this rock in turn gradually disappeared, and was replaced by calcareous, slaty and schistose formations.

Temperature observations have been regularly made, the temperature of both rock and air being taken. The maximum observed temperatures have been 92.2° F. in the north end and 88.7° F. in the south end. The water flowing in has sometimes had a temperature of about 91° F. The following table gives some observed averages of rock temperatures (corresponding figures for air are not given, as these would vary with the amount of ventilation):

North Heading		South Heading	
Dist. from portal in feet.	Temperature Deg. Fahr.	Dist. from portal in feet.	Temperature Deg. Fahr.
1,640	54.3	1,640	56.2
3,280	57.5	3,280	61.2
6,560	63.6	6,560	69.7
9,840	70.3	9,860	74.7
12,920	76.3	11,150	86.9
15,090	86.3	11,810	87.6
16,400	89.1		

Water has caused no trouble until recently. The north side has at no time yielded much water; at the end of September the flow from the portal was less than 30 gallons per second. The south heading struck water in some quantity at different points, mainly in the seamy layers on either side of the nearly dry antigorio gneiss. On Sept. 30 the flow from the south portal was only about 75 gallons per second; but on the morning of Oct. 1 the drills in the main heading tapped a stream of water that drove the men from the heading and compelled stoppage of work in the main tunnel. Work was then pushed in the side heading, though even here such quantities of water were encountered as to render machine drilling impossible. The total water flowing from the south portal on Oct. 1st was about 135 gallons per second, but in the three weeks following this amount increased to about 200 gallons, with no apparent decrease in pressure at the face. The flow is so great as to exceed the capacity of the ditch in the main tunnel, and part flows by way of the cross drifts out through the side tunnel, being held away from the working face of the side heading by a dam. Work in this side heading has been advanced by hand drilling about 35 ft. since the beginning of the heavy flow without striking any more springs. In the main tunnel a shaft has been carried up to the roof at a point 65 ft. back of the abandoned face, and a top heading is being driven forward from here so as to give the water larger outlet area, and thereby reduce its pressure if possible. At this shaft, also, a cross gallery is being driven to tunnel No. 2.

The work of enlarging to full section and lining with masonry in the main tunnel has not been interrupted or delayed up to the present by the water. A very advantageous feature attendant upon the flow has been the quite noticeable decrease in rock temperatures produced by it; the high temperatures, shown by the table above, had rendered the conditions for work much more unfavorable. The water itself when it first broke through, on Oct. 1, had a temperature of 65° F., and this has now decreased to 62° F. The normal amount of ventilation required has during the past summer been about 39,000 cu. ft. of free air per min., delivered into the north end, and 66,000 cu. ft. per min. into the south end.

FRENCH SHIPPING BOUNTIES, under the law of 1893, are voted a lamentable failure by M. Millerand, the French Minister of Commerce. These bounties have cost $41,805,000 in the last five years; and this sum seems to have been chiefly expended in the encouragement of the owners of sailing vessels, who thus received handsome returns on their capital regardless of cargoes. M. Millerand, in his late discussion before the French Chamber, stated that some of these sailing ships actually received $15,000 for a voyage of ten months, or about 31% on the capital involved; and these French sailing ships sometimes preferred to sail long distances in ballast, in order to avoid the delay of loading and unloading cargoes—and, under the law, they made money by so doing. The form of the law is now to be changed, and the builders and owners are to be encouraged in the building of steamers by offering them a bounty, on construction, machinery and length of voyage, equal to almost 50% of the cost. But vessels built abroad are no longer to be excluded from sharing in these subsidies; and in the absence of any adequate French steamship-building industry, English ship builders see promise of profitable business, even though the bounty on foreign ships may be less than upon those built in France.

A PNEUMATIC TUBE SYSTEM OF PARCEL DISTRIBUTION IN BOSTON.

By Edward D. Sabine.*

The 10-in. pneumatic tube system recently constructed by the American Pneumatic Service Co. in the city of Boston marks a great advance in the application of compressed air to commercial purposes. The small pneumatic tube for cash and message delivery is well known both in this country and Europe, while the larger tubes for the handling of mail have been in successful operation in Philadelphia, New York and Boston for some years. The mail tube was discontinued in these cities last July on account of lack of funds, but its loss is being keenly felt, and restoration of the service will undoubtedly be authorized by the next Congress.

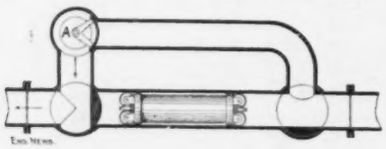


Fig. 1. Valves in Normal Position.

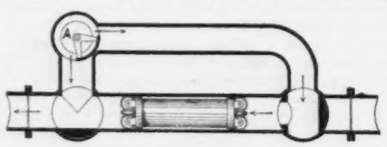


Fig. 2. Valves in Position to Send the Carrier.

SECTIONS OF TRANSMITTING APPARATUS FOR PNEUMATIC TUBE SYSTEM.
American Pneumatic Service Co., Boston, Mass.

Although many schemes for utilizing the pneumatic tube for parcel delivery were proposed during the past decade, nothing was accomplished until in the fall of 1899 a group of Boston capitalists organized the American Pneumatic Service Co., and at once began the preliminary work. Active construction commenced in September, 1900, and the entire system was in operation by Aug. 1, 1901. The main station is situated at the corner of Essex St. and Harrison Ave., in the heart of the retail shopping district of Boston. Bundles are collected from the stores and taken to the main station, which is directly connected by tube with the substation in the Back Bay, 1½ miles distant, and in the South End, about a mile away. From the South End a line runs to Roxbury, a distance of little more than a mile, and thence to Dorchester, a mile and a-quarter further. Each line consists of two lines of 10-in. cast-iron pipe laid side by side, one being used for outward, and the other for inward business. The pipe used in the straight runs is ordinary water-pipe coated as usual on the outside, but left clean inside. The joint used is the standard bell and spigot, except that the bell is counter-bored and the spigot turned to fit. In order to provide for slight variations in the diameter of the pipe, the inside is chamfered at the joints to 10⅛ ins. This joint allows a slight deflection from a straight line, which is very useful in changing grades and alinement in laying.

In laying the pipe great care was observed in addition to the usual precaution taken in laying water-pipe. Each joint before and after leading was tested with a mandrel, to make sure that no shoulder existed on which a carrier could catch. In wet ground the pipes were bedded in the best bank gravel obtainable. This care has been well repaid, for no trouble by settlement has occurred. The bends used were of iron, elliptical in section, and 10⅛-in. × 10-in., the long axis lying in the plane of the bend. The radius used for the bends is 128 ft. At either end of the bend is a tangent piece, 20 ins. long, in which the elliptical is reduced to a circular section.

The carrier is the greatest advance on previous practice of any of the novel elements of the system. It is cylindrical in form, 30 ins. long inside and 9 ins. in diameter. The door is on the side, embracing about one-third of the circumference, and is 26 ins. long. At either end of the carrier is a cast-steel head which carries lugs for the wheels; of the latter, there are five at each end equally spaced, but the wheels at the two ends do not run in the same line. The heads have flanges, 9¾ ins. in diameter, at right angles to the axis of the pipe. These flanges prevent any serious leakage of air past the carrier while running. The wheels are drop-forged from open-hearth steel, with the treads case-hardened to a depth of 1-32-in. That their life is long is certain, much longer than that of any style of packing used on sliding carriers; but the actual distance that a set of wheels can run is as yet undetermined. On the experimental line, runs of 6,000 to 8,000 miles were made, but this has already been exceeded by carriers in actual service. The elimination of packing results in an enormous saving in the construction of a pneumatic tube system, as the pipe does not have to be bored or reamed.

The sending machine, or transmitter, is a simple adaptation of the air lock. Fig. 1 shows the valves of the transmitter in normal position. Fig. 2 shows the valves in position to send the carrier, the arrows indicating the direction of the air flow, the air entering the machine from the back at A. The valves are moved by air taken from the current in the line, acting on an ordinary piston. Touching a lever starts the valves in motion and the whole cycle is completed without further intervention of the attendant. On the transit pipes directly in front of the transmitter is placed a diaphragm. This is connected to the transit pipe in two places, about 4 ft. apart, so that normally the diaphragm is balanced. When a carrier leaves the transmitter, the difference in pressure between front and rear causes the diaphragm to overbalance sufficiently to move an auxiliary valve, which controls the main cylinder and replaces the transmitter in position, as shown in Fig. 1.

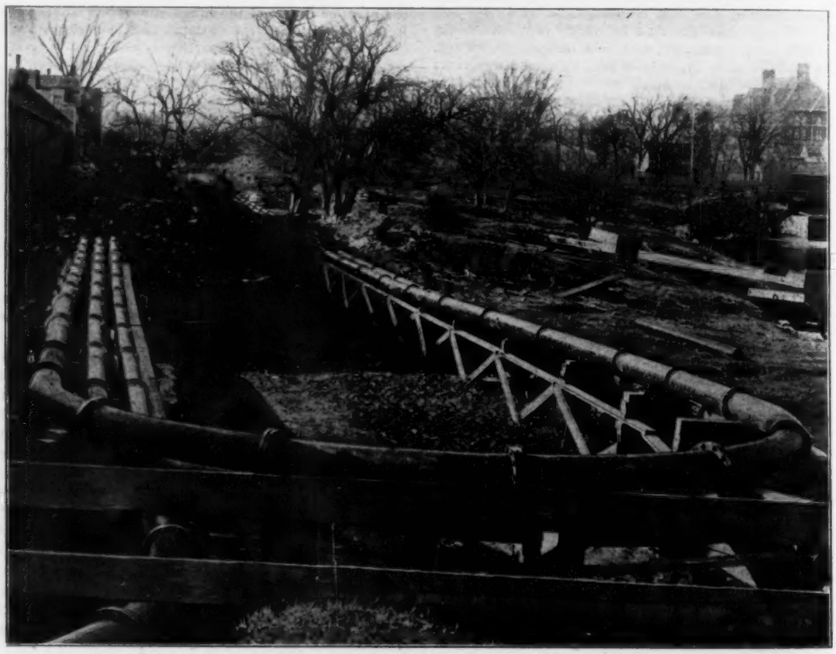


FIG. 3. THREE LINES OF 10-IN. PNEUMATIC TUBES, SHOWING CURVE CONSTRUCTION.

The receiving terminal is even less complex than the transmitter. The end of the tube is closed by a simple revolving valve, which is operated by a piston and compressed air taken from the tubes, the incoming air being diverted about 10 ft. back. When the carrier arrives, the air, compressing in front of it, brings it gradually to rest. The air from the cushion is used to operate an auxiliary valve which controls the main air supply to the cylinder. When the carrier is nearly at a standstill, this auxiliary valve permits the cylinder to open the revolving valve at the end of the pipe and the carrier rolls out. A diaphragm similar to the one on the transmitter closes the [illegible], the whole operation being automatic and [illegible]ing about four seconds.

The compressed air used is furnished by [illegible]-driven duplex compressors of the Rand [illegible] with cylinders 24 × 12 ins., with a piston [illegible]ment at 130 revolutions of slightly over 1,6[illegible]. The average pressure is only 2 lbs. per [illegible]. The compressors are driven by 550-volt [illegible] alternating-current motors of the internal [illegible]ance type. The alternating current motor w[illegible] lected on account of the absence of a comm[illegible] and all that that implies. The constant sp[illegible] this type of motor was also an inducement.

At every station is a compressor for each [illegible]ward line from that station. The air coming [illegible]s led to a large tank, open to the atmosphere [illegible] partially filled with calcium chloride. The [illegible] pipe of the compressor is connected with this [illegible] so that the air drawn in for compression p[illegible]s over the chloride, which thoroughly dries it. [illegible]y using the return air a great saving in che[illegible]al is effected, as only the air that is used to op[illegible]e the terminals has to be replaced.

Bundles are collected by team and taken to the main station, there sorted and packed into the carriers. On arrival at the substations the carriers are unpacked and the bundles turned over to the drivers for delivery. As it takes but three minutes for a carrier to go to the Back Bay Station, a mile and a-half away, some idea may be had of the saving of time.

ESTIMATING THE COST OF CONCRETE.

By Halbert Powers Gillette.*

There is data in abundance relative to the cost of concrete; indeed, the cost of no other engineering structural element has received so much attention from writers. Unfortunately, however, the differences to be found between authorities are so great as to demand investigation.

The theory upon which is based the estimate of materials required in making concrete is exceedingly simple and well known. To determine the exact amount of concrete that will be produced from any given proportion of ingredients whose voids are known, the process, according to the generally accepted theory, is as follows: First, assume that the cement fills the voids in the sand. Then, if there is an excess of cement over voids it may be considered as forming that much additional mortar; thus, if the mortar is 1 of cement to 2 of sand and the sand has 35% voids, multiply .35 × 2 and the product 0.7 is the voids which

*Chief Engineer, American Pneumatic Service Co., 89 State St., Boston, Mass.

*701 Powers Block, Rochester, N. Y.

the cement fills, leaving 0.3 of cement to spare, thus producing 2.3 mortar. Proceed in similar manner with the mortar and broken stone; thus, if the concrete is 1-2-5 (that is, 1 of cement, 2 of sand and 5 of stone), with 40% voids in the stone, it follows that $.40 \times 5 = 2$, which is the amount of voids in the stone which the mortar will fill, leaving 0.3 excess, so that the finished concrete is 5.3, the cement being unity.

Usually the unit of cement is the barrel, which is often assumed to measure 4 cu. ft., then $5.3 \times 4 = 21.2$ cu. ft. of concrete will be made with each barrel of cement, whence 1 cu. yd. of concrete will require

$$\frac{27}{21.2} = 1.27 \text{ bbls. cement.}$$

All of this is a delightfully simple process of arithmetic, the only objection to it being that the results of actual trial seldom accord with the theory. The major portion of this article will be devoted to a discussion of the reason why the old theory fails, and the presentation of a new theory that accords with facts.

In the first place, it is assumed that the cement will entirely fill the voids in the sand, if there is

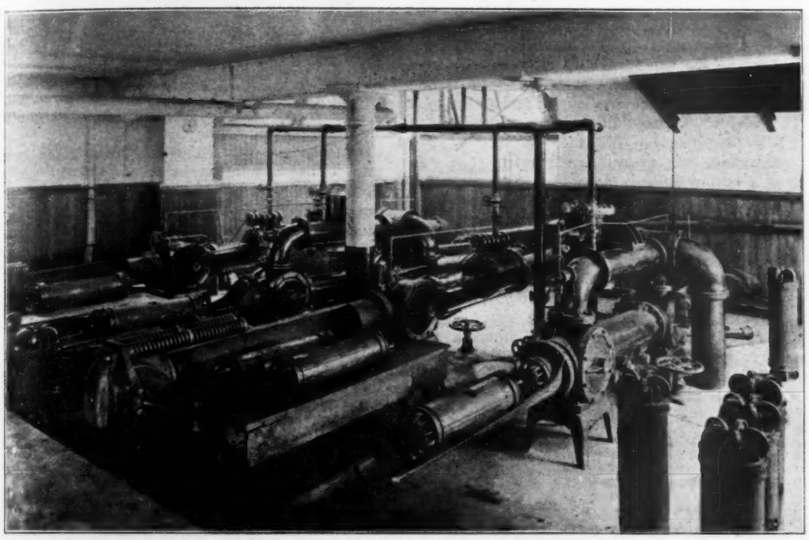


FIG. 4. RECEIVING AND TRANSMITTING TERMINALS OF PNEUMATIC TUBE SYSTEM, AT MAIN STATION OF AMERICAN PNEUMATIC SERVICE CO., BOSTON.

sufficient cement, but this is seldom the case, for two very good reasons. Sand nearly always contains a quantity of dust almost as fine as the cement; the dust has voids which, however, the cement cannot fill; for it is obvious that mixing two materials whose particles are equal in size can result in no shrinkage of volume. The per cent. of voids in the sand, therefore, is not the sole criterion. The actual size of the voids must also be known, and only a test upon the given sand will determine its capacity to absorb cement paste. I will cite a few experiments to show how wide is this variation in sand.

F. J. Preston states that using English Portland cement in a proportion of 1 of cement to 2 of sand he secured 2.25 of mortar.

Molesworth states that 1 of Portland cement + 2 of sand = 2 of mortar.

Geo. W. Rafter states that using 1 of American Portland and 2 of sand (33% voids) he obtained 2.36 of mortar.

Now this last result is absolutely unaccountable, except upon the theory that all the voids in the sand were not filled by the cement. From a number of experiments I have concluded that ordinarily about one-fifth of the voids of sand are not filled by the cement.

Broken stone, even when screened, shows a similar failure of the mortar to fill the voids; but this is more probably due to the fact that mortar, unless very fluid like grout, lodges between the adjacent pieces of stone and holds them apart so that no amount of ramming in 6-in. layers will reduce the stone to the same volume it had before mortar was added. It is, moreover, certain that concrete is ordinarily porous, that is, it contains many large voids not filled at all by mortar. At any rate, broken stone, like sand, has about 20% of its voids unfilled, or there occurs that amount of increase in its voids upon adding mortar. There is yet another fact that must not be overlooked; the cement packed in barrels swells 20 to 40% when dumped out loose. I will cite my authority for this statement in detail presently, but now I merely wish to formulate our theory.

If the loose cement is mixed with water it shrinks, due to the puddling action, and it shrinks back to a volume but slightly greater than the volume of packed cement in the barrel. Now, it is evident that only the volume of this puddled cement can be counted upon to fill the voids in the sand, yet no doubt most engineers in applying the theory above outlined, do not take into consideration this fact. As cement is so frequently shipped in bags, it follows that the unit of measure is ordinarily the barrel of loose cement, yet 1 cu. ft. of loose cement may become only ⅔-cu. ft. of paste. No theory is, therefore, correct that does not take this phenomenon into consideration.

Applying to the old theory the corrections that I have just outlined, and expressing the new theory in form of an equation, we have:

$$N = \frac{27}{p + l\,[(1 - 0.8\,v)\,x + (1 \quad 0.8\,v)\,y]}$$

In which,

N = number of bbls. of cement required to make 1 cu. yd. of concrete.

p = number of cu. ft. of cement paste per bbl., which ordinarily equals volume of cement packed in the barrel.

l = number of cu. ft. of cement, loose measure, per bbl.

v = per cent. of voids in sand, ordinarily 0.3.

V = per cent. of voids in stone, ordinarily 0.4, for screened crushed stone, and 0.35 for unscreened.

x = parts of sand in concrete, cement being 1.

y = parts of stone in concrete, cement being 1.

Observe that the formula is perfectly general. for if there is no stone, $y = 0$, and the last term in the denominator disappears, leaving the formula for mortar alone. The formula is based upon the assumption that the cement is measured loose. Should it be measured packed, merely substitute p for l in the formula, since under that condition $l = p$.

If, instead of crushed stone, a mixture of equal parts stone and screened gravel (pea to egg) is used, V then becomes about .25, which is about the minimum, unless sand is present in the gravel.

It is not claimed that the arbitrary constant 0.8 used in the formula will always be found exactly right, but its use gives such close agreement with most published data relating to amount of cement required in concrete, that it may be safely used in estimating where the exact data are unknown.

And here it may be remarked that wherever a large amount of concrete is to be laid, the engineer should make a fair-sized batch of concrete, using the sand and other materials that are actually to be used in the construction. Thus and thus only can a close estimate be made, and the information so secured should be furnished to every contractor contemplating bidding.

By doing this the engineer will frequently save his employer thousands of dollars, for when contractors guess they generally aim to guess high enough, and as will presently be seen more clearly, a guess is very apt to be 20% off.

I have looked diligently through the well-known text-books to find a theory or method whereby a fairly close approximation might be made; but aside from the erroneous one at the head of this article, none has been found, and the above formula is offered as better than a guess, and second only to an actual test.

It will be observed that p and l are very important factors in our formula. I cannot find in Baker's "Masonry" any mention of the ordinary value of p; that is, the cubic contents of a cement barrel.* Originally, cement barrels doubtless were the same as flour barrels in size, containing 3 bu. or 3.75 cu. ft., but some data taken from Engineering News, Oct. 4, 1900, shows clearly that there exists considerable variation in size of Portland cement barrels:

Portland cement brand.	(1) Capacity of bbl. cu. ft.	(2) Actual contents packed measure.	(3) Volume when dumped loose.	Difference between (1) & (2).	Difference between (2) & (3).
Giant	3.5	3.35	4.17	4%	25%
Atlas	3.45	3.21	3.75	4%	18%
Saylors	3.25	3.15	4.05	3%	30%
Alsen	3.22	3.16	4.19	2%	33%
Dyckerhoff	3.12	3.03	4.00	3%	33%

The measurement of a box of loose cement after jarring it by rocking over a bar, appears to be a mean between loose and packed; while sifted cement is 10% more bulky than ordinary loose cement.

Barrels of English Portland used by Gillmore and those that I have used contained 3.75 cu. ft of packed cement, and swelled 20% to 4.5 cu. ft. loose. Gillmore gives an example of French cement that swelled 40%.

From data given by Spaulding (likewise in abbreviated form by Baker), I find that on an average 1 bbl. of Portland having a packed capacity of 3.75 cu. ft., swells nearly 20% to 4.7 cu. ft. when loose; while a barrel of natural cement, loose, averages 5.3 cu. ft.; variations of 10 or 15% occurring one way or the other.

We now see why estimates of cement quantities in concrete are so often a mere guess; but if in addition to the uncertainty of brand and size of barrel that will be used, the specifications are ambiguous as to whether cement shall be measured loose or packed, well may the contractor knit his brows when he comes to bidding on concrete. It is apparent from the table that if cement is to be measured by the packed contents of the barrel, Giant, at $2.00 a bbl., is as cheap as Dyckerhoff, at $1.80, yet this important fact is seldom given consideration even by experienced contractors.

From all this discussion it will be seen that tables such as are found in Baker's "Masonry," giving the number of barrels of cement required to make a cubic yard of mortar are exceedingly misleading, for no mention is made of variations in size of barrels. It is, therefore, preferable to use some such formula as above given, referring to a table only as a check.

To illustrate the application of the formula let us assume that it is desired to ascertain the quantities of material for a 1-2-5 concrete, in which the voids in sand $v = 0.3$, the voids in stone $V = 0.4$, the volume of a loose barrel of cement $l = 4.5$, and of a packed barrel $p = 3.75$. In this case, since there are 2 parts of sand, $x = 2$, and 5 parts of stone $y = 5$,

$$N = \frac{27}{3.75 + 4.5\,[(1 - 0.8 \times .3)\,2 + (1 - 0.8 \times .4)} = 1.04.$$

*Since writing the above I have received a copy of the last edition of Baker's "Masonry Construction," wherein the size of cement barrels is given.

The amount of sand is evidently

$$\frac{4.5 \times 2 \times 1.04}{27} = 0.35 \text{ cu. yds.}$$

While the amount of stone is

$$\frac{4.5 \times 5 \times 1.04}{27} = 0.87 \text{ cu. yds.}$$

per cu. yd. of concrete of the proportions and quality given.

In the foregoing discussion we have overlooked one factor, to wit: the ramming of the concrete.

While loose stone may be consolidated about 10% by ramming, well-rammed concrete is only about 4% heavier than concrete where such an excess of water is used that it quakes under the tamper; so that ramming causes only about 4% variation in volume of concrete. This fact I have gleaned from the tables of tests upon concrete by Geo. W. Rafter, published in the N. Y. State Engineers' Report of 1897. That report contains an immense amount of valuable data upon the strength of concrete, the existence of which appears to be unknown to many.

In recent discussions the consensus of opinion of experienced engineers has been that it is preferable to make concrete with an excess of water, for the puddling action of the water insures the filling of all voids and produces a more uniform concrete than when made dry and rammed. Some of the older authorities have stated that ramming adds 33% to the strength of concrete. Mr. Rafter's experiments show no such difference. Concrete in which an excess of water was used (jelly-like under the ram) is only 12% weaker than concrete mixed with the least possible water and vigorously rammed, while concrete as ordinarily made and moderately rammed is only 6% stronger than wet concrete. Even were compressive strength the prime requisite, wet concrete, it is evident is so slightly inferior to dry that its greater uniformity far more than counterbalances the difference in strength. But while in the midst of this digression it may be well to add that concrete is seldom used merely for its compressive strength, but for its solidity and weight. In a pavement foundation, for example, concrete serves both to shed water and to distribute concentrated wheel loads over a large area of subsoil. Actual crushing strength aids but little in accomplishing either of these ends; and it is certain that a concrete having no unfilled voids is less apt to yield under pressure and jarring than a stronger (in spots) concrete containing voids. A wet concrete should, therefore, be specified for street foundations.

To resume our discussion of cost of concrete, having determined the quantity of cement, which is by far the most important item, we pass to a consideration of the labor item.

Turning to Baker's "Masonry," we find, after a quotation from Gillmore of an example where mixing and placing concrete cost one-quarter of a day's labor, that "the amount of labor required was unusually small, this item alone being frequently 6 to 8 times as much as in this case." All I have to say regarding this statement is that wherever it has required 1½ to 2 days' labor to mix and lay a cubic yard of concrete, the laborers must have been half asleep or working by the day for some municipality.

The ordinary cost to contractors is 0.4 to 0.5 of a 10-hour day's wages per cubic yard of concrete, although occasionally it may be as low as 0.3 of a day where two mixing gangs are worked side by side under separate foremen. In such a case, the rivalry between the gangs where the progress of the work can be seen at a glance, as in laying pavement foundations, will insure a saving of at least 25% in the labor item. The following, taken from my note-books and time-books, indicates the ordinary cost of concrete mixing and laying.

Case I. Laying 6-in. pavement foundation. Stone delivered and dumped upon 2-in. plank laid to receive it. If dumped directly upon the ground it costs almost twice as much to shovel it up. Sand as well as stone dumped along the street, so that the haul in wheelbarrows to mixing board was about 40 ft. Two gangs of men working under separate foremen, each average 4.5 cu. yds. concrete per hour. This was a fair rate, but, if after mixing, the concrete had been wheeled any distance greater than 20 ft., it would have cost 8 cts. per cu. yd. per 100 ft. lead with wages at 20 cts. per hour. Wages, $2.00 for 10 hrs.

The itemized cost was as follows:

	Day's labor per cu. yd.
4 laborers in each gang filling barrows with stone and sand ready for the mixers	0.09
10 mixers, wheeling, mixing and shoveling to place (3 or 4 steps)	0.22
2 men ramming	0.045
1 foreman at 35 cts. hr. and 1 water boy 5cts., equivalent to	0.045
Total, day	0.40

Case II. Sometimes it is desirable to know every minute detail of cost, for which purpose I give the following, the conditions being the same as Case I.:

		Per cu. yd. day labor	Per cu. yd. cost.
3 men loading stone into barrows		.06	$0.12
1 man loading sand into barrows		.02	.04
2 men ramming		.04	.08
1 foreman and 1 water boy equivalent to		.035	0.7
9 men	wheel sand & cem't to mix. board	.02	.04
	wheeling stone to mixing board	.026	.052
	mixing mortar	.013	.026
	mixing stone and mortar	.049	.098
	placing concrete (walking 15 ft.)	.072	.144
Total		.335	.67

In one respect the above is not a perfectly fair example (although it represents ordinary practice), for the mortar was only turned over once in mixing instead of three times, and the stone was turned only twice instead of three or four times. Water was used in great abundance, and by its puddling action probably secured a very fair mixture of cement and sand, and in that way secured a better mixture than would be expected from the small amount of labor expended in actual mixing. About 0.06 day more per cu. yd. spent in mixing would have secured a perfect concrete without trusting to the water.

Case III. In this case the gravel and sand forming the concrete were wheeled in barrows a distance of 100 ft. to the mixing board at the foot of steel cylinders, into which concrete was dumped after raising it 20 ft. in skips. Two cu. yds. concrete laid per hour by the gang. Wages, $2.00 for 10 hours.

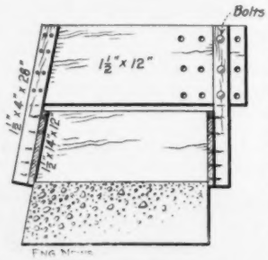
	Per cu. yd. day labor	Per cu. yd. cost.
6 men wheeling materials and mixing	0.30	$0.60
2 men dumping skips and ramming	0.10	0.20
1 team & driver @ 40 c. hr., equivalent to	0.10	0.20
1 foreman @ 30 cts. hr., equivalent to	0.075	0.15
Total	.575	1.15

Had the job been larger more men would have been employed to reduce the fixed expense of team time, for a team can readily raise 12 cu. yds. an hour, using a derrick and skips. The foreman worked on the mixing board himself in this case, so that the actual labor item was 0.45 day (of 10 hours) per cu. yd. of concrete.

Case IV. Building a wall 7 ft. high. Frames were made and placed by a carpenter and helper at $8 per M. B. M., wages being 35c. and 20c. an hour respectively. Materials were dumped from wagons alongside mixing board. Ramming was unusually thorough. Foreman's fixed expense high, due to small number in gang; 2 cu. yds. laid per hour by the gang.

	Per cu. yd. day labor	Per cu. yd. cost.
7 mixers	.35	$0.70
2 rammers	.10	.20
1 foreman, 35 cts. hr. and 1 water boy, 5 cts., equivalent to	.10	.20
Total	.55	1.10

Upon reviewing these four examples it will be observed that cutting out expense chargeable to foremen, the cost, or rather the labor item, varies little from 0.45 day (of 10 hours) per cu. yd. of concrete. The gangs were under entirely different foremen in different states of the Union, and wages varied from 12½ cts. per hour to 20 cts., although to have a uniform standard of comparison I have assumed 20 cts. The engineer who bases his estimate of actual cost of contract work upon 5 hours' wages per cu. yd. of concrete will not be far off, and usually on the side of safety. To this must be added, of course, the cost of timber for frames and cost of framing where frames are necessary. In many cases the cost of framing may be greatly reduced by using a sectional frame, such as shown in the accompanying sketch. By using the frame a section of concrete wall is built up one foot high and allowed to set; the frame is then removed by unbolting and raised one foot higher, moving the rear face of the frame is sufficient to allow for the batter of the wall. In this manner a wall of any height may be built with a frame only a foot high.



Sketch of Sectional Frame for Concrete Wall Construction.

In conclusion I would say that in estimating the probable bidding price of concrete, at least 25% should be added to the estimate of actual cost to allow for profits and contingencies; for the engineer cannot be certain that the contractor will be able to estimate as closely as he does himself. On small jobs much larger margins than this must be allowed for profit, although it is not uncommon to see such work estimated at the prevailing contract prices for larger jobs.

SPECIAL LOCAL PASSENGER SERVICE ON A STEAM RAILWAY TO COMPETE WITH AN INTERURBAN ELECTRIC ROAD.

The Dayton & Union R. R. is a line 47 miles in length extending from Dayton, O., to Union City, Ind., and owned jointly by the Cincinnati, Hamilton & Dayton Ry. and the Cleveland, Cincinnati, Chicago & St. Louis Ry. As about 50% of the revenue is derived from passenger traffic, the recent paralleling of the line by an electric railway is a matter of serious importance, and prompt measures have been taken to meet the competition by improved service and accommodation. To provide for additional service two cars have been built which in general style resemble those used on electric interurban lines, but are of heavier construction. Each car is operated independently, the locomotives used being of the eight-wheel type, with cylinders from 16 to 18 ins. in diameter.

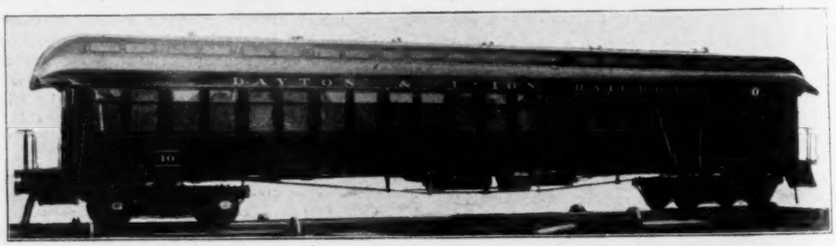


FIG. 1. SPECIAL CAR FOR HIGH-SPEED LOCAL SERVICE ON THE DAYTON & UNION R. R.
W. F. Stark, Superintendent of the D. & U. R. R.

Each car makes two round trips (or 188 miles) per day, with 54 stops to the round trip. In addition to this, there are four ordinary trains, each consisting of two day cars and a baggage car, which are hauled by similar engines. The trains and cars make a service of six trains each way per day, the new one-car trains alternating with the others. The average speed of the trains is 45 miles per hour, including stops, from which it is evident that active management and fast running are necessary. The stations are conveniently sit-

uated in the centers of the towns and villages passed, and as the terminal station at Dayton (Engineering News, Aug. 8, 1901) is also conveniently located, the road is well adapted to meet the competition of the electric cars, especially in view of the speeds attained. As to the fares, the D. & T. Ry. is unusually well situated financially, so that it can afford to reduce its rates very materially. The local fares remain about the same, but through and return tickets are sold at greatly reduced rates.

The exterior of one of the new cars is shown in Fig. 1, from which it will be seen that it is of rather unusual length, and is mounted on a pair of ordinary four-wheel passenger car trucks. Fig.

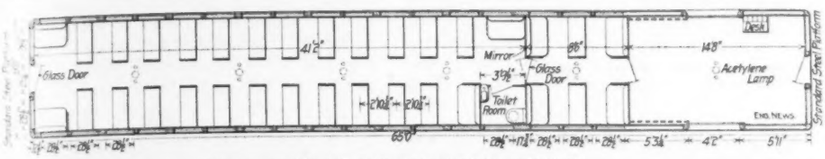


FIG. 2. PLAN OF CAR FOR LOCAL SERVICE.

2 is a plan, from which it will be seen that the car is somewhat on the style of modern interurban electric cars. Fig. 3 is an interior view, showing the lamps for acetylene gas lighting. The cars are 64 ft. 4 ins. long inside, 65 ft. over the sills, and 72 ft. 8 ins. over all. They are 9 ft. 8 ins. wide outside, and weigh 72,900 lbs. complete. The main saloon of the car is 41 ft. 2 ins. long, seating 54 persons; the smoking room is 8 ft. 6 ins. long, seating 12 persons; and at the end is a baggage room 14 ft. 8 ins. long. The interior finish is of oak and holly, with green headlining and upholstering, and the exterior is Tuscan red. The cars are fitted with steam heat and have the usual Westinghouse brake equipment. A special feature of these cars is the use of acetylene gas for lighting, on the Avery system, each car having six double-light chandeliers, with lamps of 50 c. p. The generating apparatus is placed underneath the car, in the small box shown at the left of one of the truss-rod struts in Fig. 1. This system of car lighting is described in another article in this issue.

The cars were built by the Barney & Smith Car Co., of Dayton, O. For information respecting this interesting new train service and special equipment we are indebted to Mr. W. F. Stark, Superintendent of the Dayton & Union Ry., Dayton, O.

NEEDED CHANGES IN TORPEDO BOAT DESIGN.*

By Chas. P. Wetherbee.†

If these vessels are to be sent to sea, a radical change in model is necessary. A vessel with a ratio of length to beam of 10 to 1, having the comparatively small dimensions of a torpedo boat or destroyer, cannot be considered of a seaworthy model, nor is it one that can be made sufficiently strong to go to sea in bad weather. Additional material worked into the long shallow hull does not strenghten in proportion to the weight added. The result of this addition is simply a great reduction in speed for only a slight increase in strength, while the seaworthiness of the model is as poor as before. The dead wood aft is usually cut away to give a smaller tactical diameter. On this account the vessel will not steer in a seaway at low speed. If the speed is increased sufficiently to steer, the shocks of the sea become too great for the strength of the hull. Even neglecting the question of increased strength, it is doubtful whether a faster boat would not be obtained by decreasing the ratio of length to beam. The model that shows the least resistance in the tank is not necessarily the one which will give the greatest speed when built into a boat, because the shape may be such as to require an abnormally heavy hull to get even the small strength necessary for smooth water work. All saving in machinery weight due to using a model requiring small power for a given speed is more than offset by this extra hull weight, the result being that a model less efficient from a propulsive point of view, but having a lighter hull, goes faster.

The writer is familiar with two types of boat built to fulfil absolutely the same programme. One has a ratio of length to beam of 10½; the other has a ratio of 9⅝. The tank shows that the smaller ratio gives a loss in speed of nearly 7% for the same indicated horse-power at the same displacement. The latter boat, however, when built, owing to a smaller ratio of length to beam, had a considerably lighter hull with the same strength as the former, and was enabled to carry a greater trial load; and, in addition to carry enough extra horse-power not only to make up this handicap of model, but to actually give three knots more speed and still have about 20 tons less displacement than the boat with the 10½ to 1 ratio. It is not fair, however, to credit the model with the entire difference between these boats, but a large amount is certainly due to it.

It is probable that this ratio of length to beam, 9⅝, could be reduced even more with an advantage in speed; certainly, there is no doubt but that it would make the vessel more seaworthy, and, except perhaps at the extreme speeds, more efficient from a propulsive point of view. At the reduced speeds at which the vessel is run nine-tenths of the time during her existence, the smaller ratio of length to beam is amply sufficient, and the reduced ratio of wetted surface to displacement is such that the indicated horse-power for speeds where the skin resistance is a considerable part of the total resistance, would be less with the same displacement.

This large ratio of wetted surface to displacement explains why the Admiralty speed coefficient for these long lean boats never exceeds 200, even in conjunction with a fairly good propulsive coefficient. The model is finer than necessary for the speed where the maximum Admiralty coefficient occurs.

For small vessels designed to go to sea a ratio of length to beam of 8 to 1 is certainly none too small. This would probably cause a reduction of 25% in the smooth water speed, as compared with that of a model having a 10½ to 1 ratio at the same displacement. This disadvantage would entirely disappear in a seaway, and, in addition to having a hull better proportioned for strength, the vessel would be of a fit model to keep the sea in bad weather. The ratio of depth to beam (0.66) at present in vogue should not be decreased. With the ratio of length to beam of 8 to 1, and the same depth to beam ratio which as present prevails, the present scantlings for vessels of the same beam will give a fairly strong hull, if means are adopted to

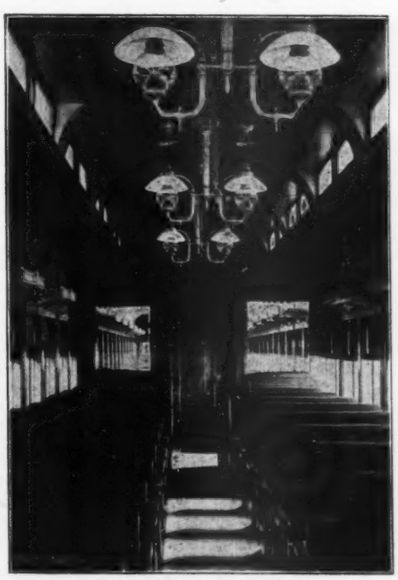


Fig. 3. Interior of Car; Dayton & Union R. R. (Showing Lamps for Acetylene Gas.)

make the longitudinal strength members, particularly the deck, capable of developing their full strength in compression without buckling.

Unlike big ships, these small, high-powered vessels develop their greatest bending moment in sagging when the ends are supported on the crests of two adjacent waves with the middle in a hollow. The bending moment under these conditions for a vessel having a 10 to 1 ratio, is nearly three halves of that found when the conditions are reversed, and when the shock which results from jumping the vessel at high speed into a fairly heavy head sea is added to this bending moment, the compressive stresses in the upper longitudinal members are by far the largest that have to be taken into consideration. As the strength of the deck against buckling in compression depends upon the moment of inertia of the cross-section and the modulus of elasticity of the steel, and not upon its compressive strength, the futility of the frequent attempts to increase the strength of this class of vessel by simply using stronger steel without increased scantlings, becomes apparent when it is remembered that the modulus of elasticity varies only 3% from 29,000,000 throughout the range from the softest flange steel to the hardest tool steel.

Another frequently made mistake caused by this same constant value of the modulus of elasticity of all steel is the allowance in calculations of a fictitious thickness for stronger steels when used in conjunction with mild steel in tension, after which the augmented area so obtained is credited with the full strength of the weaker steel. This is wrong. The two classes of steel have the same modulus of elasticity and only offer resistance in proportion to their actual areas when subjected to stresses within their elasticity limits. What actually occurs is that the weaker steel in this combination passes its elastic limit first, thus throwing nearly the entire stress upon the remaining stronger steel with disastrous results.

In order to obtain sufficient compressive strength in the deck, other means than the mere thickening of the plates must be resorted to if a respectable degree of lightness is to be retained. To this end, longitudinals of angle, bulb angle, or, wherever possible, of plate, should be worked under the deck not over 2 ft. apart in a manner similar to that by which the bottom of the boat is reinforced, and a 1½-in. non-fireproofed wood deck thickly fastened to the steel is also of great advantage in preventing the deck plate from buckling, also solving the problem of giving a deck which offers a proper foothold in a seaway.

The nearer the midship section of a vessel approaches a tube in shape, the stronger the vessel will be, and all longitudinal members are stronger in compression if given as much curve as possible in the athwartship direction. As great a crown of deck as is compatible with its use is desirable for this reason. Flat surfaces should be avoided everywhere. They are weak under all stresses except direct tension.

In addition to the unsuitable model, the torpedo boats and destroyers of the United States Navy possess some faults peculiar to themselves. They have too many useless fittings and attachments. Their machinery, through complication, is too liable to break down. Both hull and machinery have unnecessary weight devoted to the unimportant details that would serve better if expended on the vital parts.

It is unfortunate that officers connected solely with torpedo boats and destroyers in each of our designing bureaus in Washington are not usually on duty there long enough to follow a design made by them through the various stages of construction to the completed vessel. The torpedo boat suffers more than large ships from this system. The lightness of touch and line of thought necessary to design and construct a successful torpedo boat are instantly lost if the same man has charge of large ship work at the same time. It would also be of advantage to the design of a torpedo boat as a whole if some one man of great experience with them, could have the final decision concerning all matters entering into the design, no matter which bureau has cognizance of the same. Many articles now creep in that are unnecessary, and some things even are duplicated through being specified by two bureaus.

This man should also be able to take a bird's eye view of the vessel as a whole, irrespective of department, and at the same time should be able to see in his mind's eye everything as it will finally be installed in each individual department.

Space is very limited in these boats, and although each article in itself, as its drawing comes up for approval, does not look to be much, the combination of all the individual articles specified, drawn and approved, one at a time, frequently presents great difficulties owing to lack of space, and, if installed, they are inaccessible.

It is stated that a certain great shipyard in Europe has a high-salaried official whose sole duty it is to go over the ships built by that concern and make a list of what can be left off in future vessels. There is certainly a great field for him on board our torpedo boats and destroyers.

The following should be omitted from the hull and equipment as being out of place on vessels of this class:

Complicated drainage systems; water-tight magazines with their flooding, draining, lighting and ventilating apparatus for fixed ammunition; the entire system of bells, push buttons and annunciators, with their accompanying wiring in conduit and distribution boxes; all voice pipes except from forward conning tower to engine rooms and to after conning tower; the system of wiring in conduit and the type of fixtures for the electric plant.

In the steam engineering department of torpedo boats and destroyers there are too many units of all descriptions, too many compartments; in some cases, too many boilers and too many engines, too many cylinders to an engine, too many blowers, too much pipe, too many valves, and too many ways of doing each particular manœuver with the piping. The weights are pared too fine on the main engines, boilers, and blowers, while the piping, valves, fittings, manifolds, and other auxiliaries are no lighter than on any other class of ship. Pipes need not have the same allowance in thickness for wear as is given to a battleship, for the vessels are shorter lived.

*Abstract of a paper read at the ninth general meeting of the Society of Naval Architects and Marine Engineers, held in New York city, Nov. 14 and 15, 1901.

†Bath Iron Works, Bath, Me.

The engineer staff allotted to torpedo boats is far too small, as will be seen by comparing the number of men allowed with those assigned to any other naval vessel of the same horse-power. This is unfortunate, for no other type of machinery deteriorates so rapidly from neglect or requires more expert supervision.

With this small staff in view, everything should be made as simple as possible. As we have to admit once for all that these vessels are not fit for sea-going work, the evaporators and especially the distillers with their accompanying piping and pumps, should be dispensed with and be replaced by reserve feed-tanks. Ash ejectors with their piping are useless.

Four-cylinder main engines take more care and room than those with three cylinders, besides using more steam. The same power is much more easily cared for and is lighter if generated in a small number of large boilers than in a large number of small ones.

Almost no attention is paid to the economy of coal consumption. The prevailing idea that the lightest machinery can be obtained by making as light an engine as possible without regard to steam economy is erroneous, for the penalty is paid when it comes to the boilers. They are far heavier than would be necessary if a little more weight were devoted to the engines to obtain a more economical use of steam.

The above faults are in all cases not errors in design, but they simply result from the fact that these things are inappropriate on a harbor defence torpedo boat, while they are absolutely necessary on a sea-going battleship.

The solution of the so-called torpedo boat difficulties seems simple enough. The features criticized in our present boats are largely the outcome of the attempts to use the boats in a service for which the type was never originally intended. They must be restricted to harbor defence, and a new type more in the nature of a dispatch boat must be designed for sea-going work.

These new boats must be safe at sea in any weather, and the larger ones (from 400 to 600 tons) must be able to make good speed in anything short of the worst weather. Unlike the torpedo boat, which must be invisible above all things, these boats must have enough freeboard to make them seaworthy. They should have sufficient deadwood aft to make them hold their course at low speeds in bad weather, and if a small tactical diameter is deemed necessary, add a bow rudder to get it, especially in the single screw boats. They must have a ratio of length to beam of at most 8 to 1, with a ratio of depth to beam of 0.7. Make the hulls amply strong and if the vessels are of 200 tons or under, use the composite construction instead of steel plating for shell and deck. After a strong, seaworthy hull and ample necessary equipment and ordnance are provided, I would turn my attention to getting as much simple reliable power into them as possible with the necessary coal and water. These vessels must have evaporators, but I do not regard distillers or ash ejectors as necessary.

As to machinery, I should use a reliable type of bent tube water-tube boiler and rugged three-cylinder triple-expansion engines throughout the class. The engine cylinder ratio should not exceed 5 to 1, as these boats will run most of the time at reduced power.

I would never use two engines where one would do. Providing for emergencies in the way of breakdowns, by duplicating moving parts in the smaller class of boats, is more likely to be the cause of these same breakdowns. As boats having less than 1,000 HP. will hardly be constructed for this service, we can neglect any powers up to that amount. The arrangements for powers above 1,000 would be as tabulated below:

1,000 I. HP.	to	2,500 I. HP.,	2	boilers,	single screw.
2,500	"	" 4,500	"	2	"	twin screws.
4,500	"	" 8,500	"	4	"	twin screws.
8,500	"	" 12,500	"	6	"	triple screws.

These powers are the forced draft power, and they could be maintained for only about four hours. The cruising power would be about half of the maximum.

Triple screws are adopted for the larger powers, as their engines fit into boats of these dimensions better than large twin-screw engines, and at the same time the proper propeller area can be obtained without excessive draft of water.

Simplicity should be the motto throughout the design, and nothing that can possibly be dispensed with should be incorporated into either hull or machinery.

CAR LIGHTING BY ACETYLENE GAS ON THE AVERY ACETYLITE SYSTEM.

Numerous experiments are being made with the lighting of railway cars by acetylene gas, and one of the most extensive applications of this illuminant has been made by the Avery Acetylite Co., Bedford Building, Chicago, Ill. The Chicago, Milwaukee & St. Paul Ry. has been operating 25 day coaches lighted by the Avery system for about five months; the new day cars of the Dayton & Union Ry., described on another page of this issue, are equipped with this system, and cars have also been operated experimentally on the Pere Marquette R. R. and the Canadian Northern Ry.

The apparatus with its connections, as applied to one of the cars of the Chicago, Milwaukee & St. Paul Ry., is shown in Fig. 1. The generating apparatus is contained in a small tank under the car, attached to the sills, a single generating set supplying gas enough for 14 jets for 20 hours. For sleeping cars or other equipment making long runs, two generating sets are used. In the wooden tank A floats the seamless steel pot B, containing the carbide, the pot having a cast-iron cover fitted with a gas-tight gasket joint. The cover has a handle, C, for convenience in removing or carrying the pot. Within the pot is the vertical stem D, welded to the bottom and having the top threaded for the cap-nut E, by which the cover is secured, a gasket being placed between the nut and the cover. In the enlarged base of the stem is a check valve F, admitting water from the tank to ports G, while the check shield H compels the water to pass down to the bottom of the pot before reaching the carbide. As the carbide gradually absorbs the water, it becomes heavier and the pot sinks, thus maintaining a uniform head of water in the tank, at the level of the hole in the overflow pipe J, the outlet of which passes through the bottom of the tank at K. A spiral spring under the pot checks its motion. The tank can be drained when required by the outlet L, the valve of which is operated by the handle M. A plate N is placed on top of the carbide charge, and the gas generated passes out through the pipe O, the gas cock on this pipe being operated by the handle P. The front of the tank is attached to the car framing by hanger pins through the eyes Q, and the tank is pivoted at R, so that when the hanger pins are released the tank tilts outward and downward sufficiently to enable the pot to be withdrawn for recharging. A small pipe from the train pipe of the steam heating system prevents the water from freezing in cold weather, but this is only required when the lights are not burning, as the generation of gas produces enough heat to prevent freezing when the apparatus is in operation.

After passing the generator gas cock P, the gas is led to a storage and condenser tank S, a relief valve T (set to lift at 15 lbs.) being placed in the pipe betwen the gas cock and the tank. At the outlet from the tank is the pressure regulator U, maintaining a hydrostatic pressure of about 3 ins. in the supply pipe. Beyond this, the pipe is led under the car to the toilet room, through which it passes up to the roof, the supply pipe being carried along the outside of the roof. The main gas cock V is under the car, and is operated by a handle W, enclosed in a locked cabinet in the toilet room. From the roof pipe, branches are carried to the chandeliers, toilet room and platform hood lamps, etc., each individual burner having a cock, as shown at X, X. The burners are always kept turned full on when the lights are burning, and when the amount of light is to be reduced (as after midnight) some of the burners are shut off entirely.

For charging the generator, the tank is unlocked, the hanger pins at Q are withdrawn, and the tank allowed to tilt until it hangs by the chains or springs. The cock P is then closed and the pipe disconnected by the union at O. The pot is immediately removed, the cap nut, E, unscrewed and the cover taken off; the inner plate, N, is removed and the contents of the pot are emptied into a sieve of ¼-in. mesh. After cleaning, the pot is recharged with about 25 lbs. of carbide, enough to half fill the pot. Any hard lumps of the old charge which will not pass through the sieve are used as a part of the new charge, being placed on top of the fresh carbide. The cover is then put on and secured by the cap nut, and the pot put back in the tank and immediately connected with the gas pipe union at O, the cock at P being then opened. The tank is swung back into position and secured, filled with water until it overflows at K, and is then locked. The charging is done every day as a rule, and on the C., M. & St. P. Ry. this work is done by the car cleaners. When the tank is full of water, if the pot can be pushed down at least 3 ins. by hand and floats up again promptly, it may be assumed that the generator does not need recharging.

In Fig. 2, the car cleaner is shown removing the old charge, which has several large hard lumps on

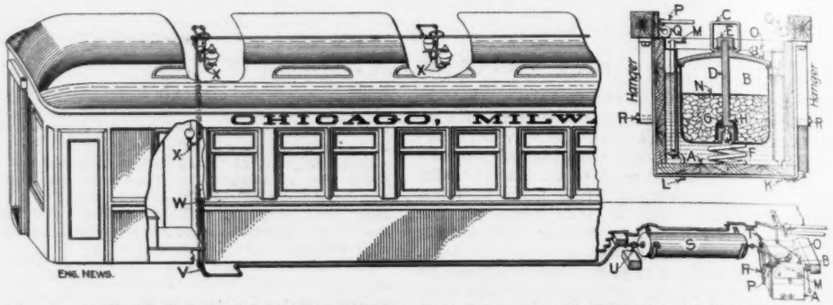


FIG. 1. GENERATING PLANT AND CONNECTIONS FOR CAR LIGHTING BY ACETYLENE GAS.
Avery Acetylite Co., Chicago, Makers.

top. The sieve, it will be noticed, is upside down; but this is simply in order that the picture might show that it is a sieve. The pot is placed on a piece of canvas, so that no dirt may stick to the bottom and so get into the water.

A PROPOSED SPECIAL METER SCHEDULE TO CHARITABLE, RELIGIOUS AND EDUCATIONAL INSTITUTIONS IN BALTIMORE.

An interesting report adverse to exempting religious and charitable institutions from charges for public water supply, but favoring reduced rates, has been made to the city council of Baltimore, Md., by the water board of that city. It appears that while some of these institutions have been charged for water heretofore, 37 have had free water and others have had special rates; also that an ordinance placing additional institutions on the free list has been introduced in the city council. The water board advises that a schedule of meter rates be adopted and enforced, based upon the extent to which various charitable institutions are free, with special meter rates, also, for churches and other religious organizations.

The present rates for metered water are about 6½ cts. per 1,000 gallons. The rates specified in the proposed ordinance are given in the Baltimore "Sun," of Oct. 29, as follows:

Orphan asylums, reformatories, homes for the aged, homes for the fallen and other charitable institutions where free care and treatment are given to more than two-thirds of the inmates and patients, 1 ct. per 1,000 gallons will be made.

In such institutions where free care is given to between one-third and two thirds of the inmates, 2 cts.; where free care is given to less than one-third, 3 cts. per 1,000 gallons.

For all such institutions where no free care or treatment is given 4 cts. will be charged.

Churches, missions, Christian associations, church settlements, temperance unions, deaconess' homes and other religious institutions, 4 cts.

Schools, academies, colleges and universities, 5 cts.

In its report on the subject the water board says that to abolish all charges for the sevices under consideration would reduce the annual water revenue by $5,270, as follows: Churches, $3,842; orphan asylums, $28; homes for the aged, $365; hospitals, etc., $995; reformatories, $40. The council, last spring, reduced the rates about $170,000, total, so any further reduction would result in a deficiency in the water department. This phase of the subject, however, is the least important one, as the board proceeds to show, as follows:

We believe, however, that this is not the most impor-

tant reason why the charges for water to such institutions should not be entirely abolished. As a matter of fact the amount of money involved is a small proportion of the total revenues of the city from water rents, and in the majority of the institutions under consideration the water rent even at present rate would be but a small fraction of their total expenses. What is vitally important, however, is for us to see that every precaution is taken to prevent a waste of water. The necessity for such precaution is shown by the following statement of facts: Every thousand gallons of water supplied to the city costs in absolutely necessary expenses over 4 cts. The consumption of water in this city has more than doubled in the last 15 years, and in the same time the consumption of water per capita has increased nearly 100%. Not much more than half of this consumption represents legitimate and necessary use. The balance is wasted through leaking mains, defective plumbing, etc. As every gallon of water supplied by the city is an item of expense, and as the great increase in consumption of water is taking us by leaps and bounds nearer to the limit of the capacity of our present sources of supply to meet the consumption, it seems to us absolutely essential that the water department should in every case retain some check upon all consumers of water in the city—not to curtail or hamper in any way legitimate use, but to prevent needless waste. The abilition of all charges for water service to these institutions will remove the only check which the department has on the possible waste of water at such institutions, as we have no authority to inspect or compel the repair of their plumbing or to watch for needless waste at the fixtures. We do not in any way mean to imply that the governing boards or officials of any of these institutions would for a moment permit needless waste of water if it could always be brought to their attention. We simply state that only the most constant and rigid inspection by them of their own plumbing and the most careful supervision by them of all water used on their premises would be as effective in preventing a waste of water as would the placing of meters on the supplies of these institutions, with some charge for the water used, however nominal such a charge might be. If this plan should be adopted and these institutions should be charged only a fraction of the present water rates by meter, nothwithstanding that the total amount so charged to any institution would be so small as to be practically no burden whatever, still any waste of water would be at once called to the attention of both the water department and the officials of the institutions, and the latter would then be led to make such repairs or take such precautions as would keep down the waste of water on their premises.

In fixing the water rates for these institutions we believe that if only those which give free treatment or care to patients or inmates are to receive concessions, discrimination should be made between those institutions which give care or treatment free to the persons received but paid for in every case by the city, state or some private corporations, and those which give care or treatment absolutely free to the persons received, with no charge to relatives, friends, guardians, employers or city or state governments, and that the former institutions should be classed with those that give no free treatment.

We also believe that any concession in the matter of water charges to these institutions should be in some degree proportional to the extent to which the institutions are free.

We also believe that if churches are to receive concessions in charges for water service other religious institutions, equally meritorious, such as Christian associations, missions, temperance unions, deaconess' homes, etc., should receive the same concessions. Some concessions should also be made to institutions of mercy, whether giving free care or treatment for inmates or patients or not, for they are charitable institutions to the same degree as are many churches. For the same reason educational institutions should also receive some concessions.

OPERATIONS OF THE ALBANY WATER FILTRATION PLANT.*

It is gratifying to report the continued good work and benefits obtained from this valuable addition to our plant. It is no longer an experiment, as two years of uninterrupted operation have proven its design to be complete for the work expected from it, that the work can be done for a moderate cost, and that its construction was thorough.

I believe that the benefits derived from it have been underestimated. It was generally believed that as a result of filtering the water there would result a large decrease in cases and deaths of typhoid fever, and also other water-borne germ diseases. Just what were these water-borne germ diseases, other than typhoid and cholera, have not been stated. An examination of the health records of the city shows some interesting features coincident with the commencement and continued operation of the filter, as follows:

FIG. 2. CLEANING AND CHARGING GENERATING APPARATUS OF AVERY ACETYLITE CAR LIGHTING SYSTEM; C., M. & ST. P. RY.

DEATH RECORD.

	General			Diarrhœal			Typhoid		
	Av. previous 10 yrs.	1899	1900	Av. previous 10 yrs.	1899	1900	Av. previous 10 yrs.	1899	1900
October	153	138	144	5	2	5	4	4	5
November	162	138	135	3	0	1	5	0	4
December	194	148	133	6	1	0	7	1	0
		1900	1901		1900	1901		1900	1901
January	235	135	188	6	1	2	11	3	2
February	197	146	157	6	2	0	11	1	3
March	215	180	164	5	5	1	12	3	1
April	197	202	156	4	1	0	9	5	1
May	173	152	139	3	0	1	4	4	1
June	159	112	145	10	7	1	4	1	3
July	191	162	142	39	27	11	4	3	0
August	162	116	134	21	16	14	7	6	3
September	148	125	139	12	5	12	6	4	4
Totals	2,186	1,754	1,776	120	67	48	84	35	27
Reductions, %		19.77	18.76		44.17	60.00		58.33	67.86

There has been no general sanitary improvement in the city in this time other than the improvement of the water due to filtering. These figures show facts, and should be susceptible to accurate interpretation. My inference from them is, that, as a result of the pure water now being supplied, there is a better general condition of health, as shown, and a decided reduction in diseases caused by filth and disease germs that are water borne.

The physicians of the city, almost without exception, have maintained their interest in helping to determine the effects of the filters. They have given detailed reords of each case of typhoid fever, and the tabulation of records shows that of the 27 deaths from this cause for the year, eight were alien cases, two of which were from infected milk; two others were doubtful, as being caused by conditions in this city, leaving 17 deaths as not proven to causes outside of the city.

It is noteworthy, that whereas typhoid fever originally (normally?) is a summer and fall disease, that this city has always had the most cases in the winter and early spring, which indicates that the germs have been brought into the river by floods and freshets, thus causing the disease, while as a result of the removal of these germs by the filter, now the period of the disease has changed from the winter and spring to the fall months, where it properly belongs.

Accompanying this are tables of records of the plant, which show as follows: The beds have been in use (since first started—Ed.) 774 days, and have filtered 10,069,075,000 gallons, for a total cost of $46,917, which analyzed, shows as follows:

	Cost per 1,000,000
Filters	$1.65
Chemist	0.28
Pumping	2.72

DETAILED COST.

Payroll: Scraping beds	$0.22
Wheeling out	.40
Washing sand	.40
Refilling beds	.27
Pumping	1.04
Chemist	.23
Labor at pumping station	.18
" at laboratory	.01
" for incidentals*	.27
" for lost time	.08
Bills paid: Filters	.10
Pumping stations	1.33
Laboratory	.05
Miscellaneous*	.07
Total	$4.65

*One-half of expense charged to each filter and pumping.

Two hundred and eight runs of all the filters have been made, giving an average of 25.1 days and 67,730,000 gallons per acre per run, at an average daily rate of 2,698,000 gallons per acre.

The removal of bacteria has averaged 99.1%. During the year (1900-01—Ed.) 48 tests for bacillus coli communis were made. In every sample of raw water they were found and averaged 18 colonies per cu. cm., and in the filtered water we obtained negative results in 31 samples, and in the remaining 17 samples the average was one colony.

*From the Annual Report of Mr. George I. Bailey, M. Am. Soc. C. E., Superintendent Bureau of Water, for the year ending Sept. 30, 1901.

THE POSTAL BUSINESS OF THE UNITED STATES, for the last fiscal year, foots up to $803,660,000 in its financial transactions. The revenue from the postal service was $111,631,193; expenditures, $115,554,920; money orders issued, $294,618,680; money orders paid, $281,554,711. There are now in office 76,948 postmasters, and over 36,000,000 money orders were issued. For the fiscal year ending June 30, 1903, the Postmaster General asks for appropriations aggregating $134,731,596, and the estimated revenue is $132,030,630. During the last year 4,154,838,300 postage stamps were issued, including 187,383,080 Pan-American stamps. Among the estimates is one of $500,000 for the resumption of the pneumatic-tube service in Boston, New York, Brooklyn and Philadelphia. Congress failed to make an appropriation for this service for 1902, and the Postmaster General recommends resumption.

TELEPHONE CABLE IN THE ST. GOTTHARD TUNNEL.

The conditions in the St. Gotthard Tunnel are peculiarly trying to metal work, and especially so to the installation of telephonic communication. The water percolating through the rock becomes charged with the acid fumes from the smoke of the locomotives, and the compound is highly corrosive.

Section of Telephone Cable Used in the St. Gotthard Tunnel.

To meet these conditions a telephone cable of peculiar construction has been lately put in place, and is described in the "Elektrotechn. Zeitschrift," for June 27, 1901, as follows:

The conductor is a paper-and-air-insulated cable made by Felten & Guilleaume. It includes seven two-wire circuits, each wire 1.8 mm. in diameter, each set being covered with paper tape to a diameter of 7 mm. These seven circuits are stranded together and covered with a triple envelope of cotton and a double tin-lead sheath. Outside the lead is a layer of waterproof compound, a strong armor of interlocking steel wires and an outer coating of jute yarn soaked in a protecting compound. The finished external diameter is 44 mm., or 1.7 ins.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, ... PRESIDENT.
D. McN. STAUFFER, ... VICE-PRESIDENT.
CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
F. P. BURT, . . . TREASURER AND BUSINESS MANAGER.

WM. KENT, E. E. R. TRATMAN, } ASSOCIATE
M. N. BAKER, CHAS. S. HILL, } EDITORS.

A. B. GILBERT, ... ASSISTANT MANAGER.

CHAS. W. REINHARDT, ... CHIEF DRAFTSMAN.

ALFRED E. KORNFELD, New York,
M. C. ROBBINS, Chicago,
S. B. READ, Boston,
ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 170 SUMMER ST.
CLEVELAND OFFICE, OSBORN BUILDING.

FOREIGN AGENTS.

C. MITCHELL & Co, Snow Hill, Holborn Viaduct, LONDON.
RUDOLF MOSSE, BERLIN and HAMBURG, GERMANY.
JOHN F. JONES, & CIE. 31 Rue de Faubourg Montmartre, PARIS.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; *6 months,* $2.50; *2 months,* $1.00. *To all other countries in the Postal Union: Regular Edition, One Year,* $7.60 (31 *shillings*); *Thin Paper Edition, One Year,* $6.31 (26 *shillings*). *SINGLE COPIES of any number in current Volume,* 15 *cents.*

In requesting change of mailing address, state BOTH old and new address; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 321 *means that subscription is paid to the* 32d *week (that is the issue of Aug.* 8) *of the year* 1901; *the change of these figures is the only receipt, unless one is sent by special request.*

ADVERTISING RATES: 20 *cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.*

In describing the remarkable long-distance electric transmission plant of the Bay Counties Power Co. of California in our issue of Oct. 3, we noted that the total distance over which current was being sent was then 184 miles. The line of the Bay Counties Co. extends from the Colgate power house in the Sierra Nevada Mountains to the city of Oakland, on San Francisco Bay, 142 miles. Here connection is made with the lines of the Standard Electric Co., which at that time extended from Oakland to San Jose, 42 miles farther. This latter line has now been extended north to Redwood City, 191 miles from Colgate, and here connection is made with wires of the Consolidated Light & Power Co., extending to Burlingame, 11 miles farther, making a total distance of transmission of 202 miles.

Our San Francisco contemporary, "The Journal of Electricity, Power and Gas," stated in its October issue that during the month of November the Standard Co.'s high-tension line was to be completed to the Eighth St. substation in San Francisco, and current from the Bay Counties system would then be transmitted over it, making the total distance from power house to substation 222 miles. This remarkably long transmission is to continue until January, when the Standard Co. will begin generating power at its own station in Amador county. Besides this, current is now being delivered over the Standard lines from Oakland to Stockton, 76 miles, or a total distance of 218 miles from the Colgate generator to the Stockton transformer. About 1,000 HP. is said to be regularly delivered over this line at the present time. These figures, it need hardly be said, far exceed anything ever before attempted anywhere in the way of long-distance transmission. Of course, it must be remembered that such feats are only made possible in California by the very high price of fuel there. It would not be possible to make a commercial success of any such system in a region of cheap coal. Nevertheless, the practicability of transmitting power over such great distances with electric currents is of the greatest interest, and well deserves record.

As stated in our previous article, the Bay Counties system is designed to operate at a pressure of 40,000 to 60,000 volts. Our contemporary above quoted states that the Standard Electric Co. recently, as an experiment, operated one of its lines for two hours in adverse weather at a potential of 80,000 volts. We have recently called attention to the extreme care which must be taken in handling currents of such enormously high potential. Recent reports would indicate that the familiarity which breeds contempt has had its usual effect in the installation of some of this high-tension work in California. The Sacramento "Bee" reports two recent fatal accidents due to persons coming in contact with wires carrying a 10,000-volt current. In one case the wire ran within a foot of the eaves of a house, and in the other the wire was within reach of the ground. In neither case was the wire bare, but its insulating covering was so light that it was pierced and a fatal shock was given when a person came into accidental contact with the wire.

As the "Bee" remarks, such an insulating covering to wires carrying high potential currents is apt to prove a danger instead of a safeguard, since the dangerous character of an absolutely bare wire would be more readily recognized. It may well be questioned whether overhead wires carrying these very high potentials should be allowed in city streets at all. Substations for stepping-down the current can be located on the outskirts of a city, or if it is deemed necessary to bring the high-potential current to a central substation, the cables should be put underground.

The growing necessity of checking water waste at all possible points, even at the risk of exciting strong popular feeling, is illustrated by the report on a meter schedule for charitable and like institutions at Baltimore, Md., extracts from which are given elsewhere in this issue. The proposed plan places the merely nominal charge of 1 ct. per 1,000 gallons on water used in charitable institutions which are absolutely free to their inmates, and receive neither city nor state aid, and gradually raises the price to 4 cts. where there is no free treatment. The larger figure is also proposed for churches and other institutions of a religious character, while for educational institutions the charge would be 5 cts. The regular meter rate is about 6½ cts. per 1,000 gallons. As to the details of this plan we have nothing to say, but the principles involved in the interests of justice to regular water consumers, and on behalf of the administration of the water department, seems to be correct. There is no end of abuse of the free water privileges granted in many cities having works under public ownership; perhaps some of the relatively few private companies giving much free service suffer even more. But great as is the waste in these quarters it is questionable whether it is not often exceeded by the municipalities themselves. Some method of control is necessary at every point where water is used, be it for private or for public purposes. It is for this reason that there is a growing tendency to charge all municipal departments for the water they use, even if it be a matter of municipal bookkeeping, only.

We strongly commend to every one interested in the "municipal ownership of public utilities," and in the closely related topic of "good government," the paper by Mr. Alex. Dow, on another page of this issue, in which some hitherto unwritten history of the Detroit municipal lighting plant is put on record. The Detroit plant is about the largest experiment in the municipal ownership and operation of an electric street lighting plant that has been undertaken in the United States. The results obtained in it have been liberally quoted in the arguments which have been carried on over the municipal ownership question during the past half-dozen years.

It has been made a text by both the advocate and the opponent of municipal ownership, and Mr. Dow's paper furnishes the key to this apparent inconsistency. He plainly shows how the same plant may be run at one time on sound business principles, and at another as a mere adjunct to a political machine.

One point which Mr. Dow brings out deserves to be still further emphasized. That is, that any committee or commission or council or board of directors—any body of men put in a position of power—ought to confine themselves to legislative work and delegate executive duties to a competent and responsible officer or officers. The failure to observe this simple principle of organization has brought shipwreck on hundreds of business enterprises, private as well as public.

Engineers are not as afraid of concrete as they used to be. There was a time—and it still exists in the minds of many members of the profession—when concrete always had to be covered up with stone. It was an accepted maxim that concrete must not be exposed to water or weather or wear. Cut stone facing was the thing for such places.

As examples of how ideas have changed, we may instance the St. Croix dam, illustrated in our issue of June 13, in which the stone and concrete have their places reversed from the usual position, the stone being on the inside and the concrete being an outside facing. This was done because a very soft stone was the only thing available for the dam. Another example of a dam with rubble stone heart and concrete face is illustrated in this issue; but the concrete facing was adopted here merely to save the expense of cutting the face stones of the dam to make a smooth overfall. Doubtless many engineers will look askance at such a construction; yet we see no reason why it should not be entirely satisfactory. The dam is in a region where ice will never trouble it, and if heavy driftwood going over during high water should gouge a hole or two in the concrete facing, it would not endanger the safety of the dam and could easily be made good as new at low water.

A large reduction in the death rates from typhoid fever and diarrhœal diseases, and also a notable decrease in deaths from all causes, has accompanied the use of filtered water at Albany during the two years the filter plant has been in operation. The exact figures, together with an itemized summary of the operating expenses per 1,000,000 gallons purified, are given elsewhere in this issue. In the two years involved a total of 10,069,075,000 gallons has been purified, at an average cost of $4.65 per 1,000,000 gallons for all operating expenses due to purification. This means only 0.465 cents per 1,000 gallons. The total cost of purification would, of course, include interest charges and depreciation on the plant. The purification works, including the auxiliary pumping station and the long steel conduit to the old pumping works, cost approximately $500,000.

This cost was met by bonds, of which $100,000 bore 4 per cent. interest, and $400,000 bore 3½ per cent., making a yearly interest charge of $18,000. At our request, Mr. Bailey has given us his ideas of the proper allowances for depreciation, as follows:

> Pumping plant, about 6 to 7%; filter beds and sedimentation reservoir not over 1 to 2%; for the steel conduit from filter plant to old pumping station I have no idea, but as this pipe is enclosed nearly throughout with concrete, I assume that depreciation and repairs will not in any event exceed 1 to 2%.

The site for the purification works cost $8,290. On this no depreciation need be allowed. If 6 per cent. depreciation be allowed on the cost of the pumping station and intake ($49,745), and 2 per cent. on the other items, excepting land, the total yearly depreciation charges will be $11,818. To this add $18,000 for interest, and the yearly capital charges become $29,819 for the first year and a little less for the second year, on account of the depreciation written off. Approximately, then, the capital charges for the two years the plant has been in operation would be $59,000. For a total of 10,069,075,000 gallons treated this gives $5.85 per 1,000,000 gallons, or $10.50 for both operating expenses and capital charges. This is practically one cent per 1,000 gallons of water purified. Certainly this is a small price for consumers to pay for the many benefits due to pure water.

SOME THINGS THAT DIDN'T GO.

Many of our readers will remember, we are sure, the widely-heralded experiments with electric traction on the Erie Canal which were conducted in 1893. A trolley wire was run along a short section of the canal, a motor was fitted to an antediluvian canal-boat and a distinguished party of guests, among them the governor of New York, was conveyed a short distance along the canal, while the band played and champagne and oratory flowed. To be sure, the electrician in charge of operations was in a state of panicky fear lest the very crude and temporary arrangement which had been rigged up to supply current to the boat should break down; and the whole performance was no more a proof of the commercial feasibility of electric canal traction than it was a proof of the Rule of Three.

Following this came the incorporation of a company, with we forget how many millions capital, to furnish current to boats on the New York canals, and the grant of a franchise to it by the state officials—for which grant the said officials were duly hauled over the coals by their party opponents. Following this came also inventions and demonstrations from inventors of other canal-boat towing systems.

All these schemes came to nothing. Had those who promoted them been a little wiser, they would have seen, what is now so plain, that the mere substitution of the electric motor for the mule or for the steam propeller cannot save the old canal system. It is too far gone to be revived by any such medicine, even if the said medicine contained any virtue at all, which never was proven.

There was another canal enterprise, undertaken shortly after the electric towing experiments, of which also great things were prophesied. A fleet of steel canal boats was built, and it was proposed to run them through from Cleveland to New York, avoiding the cost of transfer at Buffalo. There were 4 steam-equipped boats and 15 towing barges in the fleet. These vessels have been run ever since, but the profits have not been such as to attract others to engage in a similar enterprise, and they have reached so low a point that the line has been abandoned and the vessels have been sold to go to Manila for use as lighters and for local water transportation. The general manager of the system, Mr. Chas E. Wheeler, of Cleveland, is quoted by the New York "Journal of Commerce" as saying that the highest rate on east-bound freight from Cleveland to New York which the boats ever obtained was 6 cts. per 100 lbs. ($1.20 per ton). The west-bound tonnage of merchandise freight was all that saved the boat line from financial failure. Lack of terminal facilities and lack of traffic arrangements with connecting transportation lines at either end combine with the dilapidated condition of the canals themselves to make competition of the canals with the railways no longer possible. Continuing, Mr. Wheeler said:

> If New York is going to do anything for the canal, I believe the only thing left is to put it in such a position as will make it of value to the present boats. I don't believe there is a company that will build boats for the new canal. I know we would not build. Present boats are simply scrap. There are not 100 boats on the canal to-day that the underwriters classify as first-class risks. The fact is certain that, with the cessation of boat building that has taken place, within five more years, now that our boats are off, there will not be a solitary boat on that canal that will rank A1 unless very extensive repairs to the present equipment are undertaken, and these repairs will not be undertaken because present rates are unprofitable, and boat owners will not have the money. New York has to face this; she will see the canal practically abandoned because of the absence of boats to do the business. She should abandon the canals to the general government or provide proper terminals to do business.

Coming down to more recent times, it is interesting to recall the prophecies of those who foresaw disaster to United States transportation and commercial interests as a result of the deepening of the Canadian canals along the St. Lawrence to 14 ft. For a year past there has been nothing to hinder running 1,000-ton barges, or 2,000-ton barges for that matter, from the Lakes to the seaboard; but if any large current of trade has forsaken older channels to flow in that direction, we have failed to hear of it.

It is interesting to recall, in this connection, too, the famous contract of the Conner's Syndicate with the Montreal Harbor Commissioners. By this contract certain prominent capitalists of Buffalo agreed to erect grain elevators and warehouses at Montreal to cost about $4,000,000, to establish a fleet of vessels to ply between Lake ports and that point, and to transport at least 35,000,000 bushels of grain per annum to Montreal. It certainly looked like business, especially when the syndicate deposited $50,000 as a bond to insure the performance of its contract; yet two years have rolled by, and neither the grain elevators nor the floating equipment have become realities.

Still more recently another project for making use of the Canadian canals as a link in long-distance water transportation was brought forward. It was proposed to run steamers direct from Chicago to European ports without transshipment of cargo. One or two small vessels were actually loaded and made the voyage early in the present year. It was found, however, that the limit to the size and lading fixed by the Canadian canal locks was a serious barrier to economical transport; and this, together with the delays involved in passing through the long chain of canals, and the dangerous navigation of the lower St. Lawrence, caused the abandonment of the enterprise.

It has been well said that failures are often more instructive than successes. It has seemed to us that the different enterprises whose rise and fall is briefly sketched above, had enough of kinship to make it worth while grouping them together. In each case alike the existence of railway competition was an important factor in determining the final results. Railway competition to-day, moreover, means not alone the ability to move traffic at a low actual cost. It includes ability to direct and determine the course of traffic in a hundred different ways, by control of connections, by control of terminal facilities, by ability to sacrifice at one point and recoup at another, by "community of interest," and all that that implies.

It has been truly said, and indeed pointed out in these columns, that the final disappearance of competition between the railways themselves furnishes a new and powerful argument for the existence of competing water routes, owned and controlled by the Government and free to all alike. But let those who would plan such water routes be sure that they can actually do business in competition with their gigantic rivals before committing the taxpayers to expenditure upon them.

LETTERS TO THE EDITOR.

Formulas for Computing the Frustum of a Pyramid.

Sir: Referring to the formula given on p. 160a of "Trautwine's Engineers' Pocket Book" for obtaining the volume of a frustum of a pyramid, why is it that the two formulas given do not give the same result? Take a frustum of a pyramid with area of lower base 50 × 60 ft., area of upper base 30 × 40 ft., depth 1 ft. The first formula gives 2032.46 cu. ft. and the second one 2033.33 cu. ft.

Buffalo, N. Y., Nov. 25, 1901. Frustum.

(The formulas referred to in the above are:

$$V = \frac{h}{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right) \qquad (1)$$

$$V = \frac{h}{6}\left(A_1 + A_2 + 4\,A_m\right) \qquad (2)$$

Both of these formulas are correct for the frustum of a pyramid, but only the second one applies rigidly to a prismoid. The solid given in the above letter will be recognized as being a prismoid, and not a frustum of a pyramid, since its four edges, if extended, would not meet in a point. The correct value for the volume of the figure, assuming the short and long sides of the two bases to be respectively parallel, is, therefore, 2,033.33 cu. ft., which is the value given in the letter above as being found from the second formula; if the short side of one base is parallel to the long side of the other base, the value would be 2,050.00 cu. ft.—Ed.)

Concerning the Use Which the American Society of Civil Engineers Doesn't Make of Its House.

Sir: I read your comments (Eng. News, Nov. 28) on the action of the Directors of the American Society of Civil Engineers anent the use of its auditorium by other bodies, with mingled incredulity and amazement. I cannot adjust myself to really believing what you state to be the facts although I cannot doubt your accuracy. I cannot even guess at the reasons which prompted the Board, assuming that there were reasons.

When the project of building the Society House was being agitated, much stress was laid upon the desirability of providing an auditorium that should not only serve the Society's needs, in the narrow sense, but should also furnish an attractive and suitable meeting place for other bodies in sympathy,but not affiliated with ours,who might be without permanent homes. I am inclined to think that that idea found a hearty support throughout the membership.

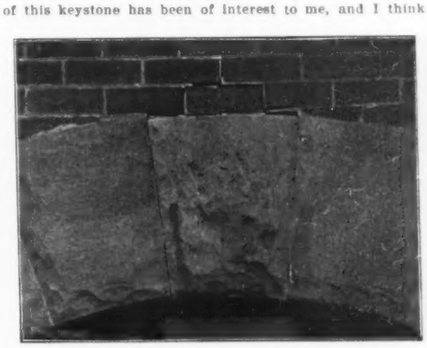
Apart from the friendly services the Society would thus be rendering, there would be the pleasure of extending hospitality, and there would also be the enjoyment by the thrifty of a not inconsiderable addition to the income account.

Of course, even if there were no good grounds for being generous, the Directors should never have taken the steps they seem to have done without carrying the matter through in a manner creditable to the Society. I sincerely trust, Mr. Editor, that there is another side to the story which you have not heard but which your article may elicit. M. Am. Soc. C. E.

(We also trust so, and shall be glad to give space to it whenever it shall be forthcoming.—Ed.)

Why Did This Keystone Drop?

Sir: Enclosed please find a photograph of the keystone in a semicircular arch, of about 12 ft. span, over the vestibule of a school building in this city. The settlement of this keystone has been of interest to me, and I think



Crown of a 12-ft. Semicircular Arch in a School Building at Portsmouth, O.

cannot but be of interest to the profession. This arch does not show a crack of any description, nor is there anything in the building to indicate the settlement of the foundation. How was it possible for this stone to settle as it has without the least displacement of any of the other stones? Respectfully yours,

S. P. Baird, Assoc. M. Am. Soc. C. E.

Portsmouth, O., Nov. 23, 1901.

"Lever" Ruling Pens and "Duplex" Ruling Pens.

Sir: In Reinhardt's "Technic of Mechanical Drafting," Chapter 1, page 7, lines 7 to 13, the following occurs:

> . . . when refilling the pen, care should be taken to readjust it to the proper strength of line; to those unaccustomed to this somewhat delicate task the use of a "duplex" pen is recommended. This pen, as shown by Fig. 1, opens with a lever, and will, after refilling, yield the same strength of line as before."

These statements are not consistent with the "duplex" pen, as this type of instrument does not open with a lever for the purpose of cleaning, and is in this respect (cleaning) an abominable tool.

The object of the "duplex" pen is to enable the draftsman to produce a "thin" line and a "shade" line at will without touching the adjusting screw. The nibs are adjusted for the "thin" line by means of the screw in the upper blade, and for the "shade" line by means of the screw under the lever. When a "thin" line is desired the pen is used in the ordinary way, and when it is desired to have the pen produce a "shade" line the lever is pressed until it comes into contact with the screw directly under it, the pressure will separate the points. The "duplex" pen never proved popular for the reason that the strained position of the hand, caused by exerting even the slight pressure necessary to separate the blades, was not conducive to good results; and there were other reasons, amongst which was the difficulty of cleaning.

We are of the opinion that the pen the author had in mind when writing the lines above referred to, was the "lever" ruling pen, shown in our catalogue Nos. 1605 and 1607 in our catalogue).

In order that the above statements regarding the "duplex" pen may not be misconstrued, the writer wishes to state that the particular type of "duplex" pen illustrated in "Technic of Mechanical Drafting" was designed and first made by Theo. Alteneder & Sons; although the idea of a "duplex" pen was not original with us.

Our object in directing attention to this error, if it is an error, is to avoid the annoying correspondence which has resulted with the readers of your book; they order a "duplex" pen but want a "lever" pen.

Very truly yours, Theo. Alteneder & Sons.

939-945 Ridge Ave., Philadelphia, Oct. 26, 1901.

(The quotation in Reinhardt's "Drafting" noted above was intended to refer to the "Lever" pen and not the "Duplex." The error will be corrected in future editions.—Ed.)

Another Diagram for Rivet Spacing.

Sir: Mr. F. L. Batchelder's very handy scheme for minimum alternate spacing of rivets (Eng. News, Oct. 31) suggested combining his curve with the "curve of minimum alternate spacing without reduction of net section," as shown in accompanying sketch.

When rivets are put in a member, the section of that member must be reduced by at least one rivet hole, and when alternate spacing is used and the distance between gage lines is 2⅝ ins., for example, the alternate spacing will be zero, according to Mr. Batchelder's scheme, i. e., one rivet will be directly over another, in which case the section is reduced by the value of two rivet holes. Now there is a distance x which will make the section B C D E equal to section B, and the value of this distance is $x = \sqrt{2yd + d^2}$. The curve herewith is a combination of the circular curve used by Mr. Batchelder and the parabolic curve given by above formula (calculated for ⅞-in. rivets, d or the diameter of the rivet hole, being taken as 1 in.). The point of intersection of the two curves, y = 1⅝ ins., x = 2 1/16 ins., is where both conditions are fulfilled; i. e., when gage is 1⅝ ins., and alternate spacing of ⅞-in. rivets is 2 1/16 ins., the rivets will be at minimum distance (3 diameters, or 2⅝ ins.) c. to c., and the section B C D E will equal section A B. When the gage is less than 1⅝ ins., the rivets will be 2⅝ ins. apart c. to c. (minimum distance given by circular part of curve), while the section B C D E will be greater than A B; when gage is greater than 1⅝ ins., the distance x (given now by the parabolic part of curve) will be such that these sections are equal, while the rivets will be more than 2⅝ ins. apart c. to c. Yours truly,

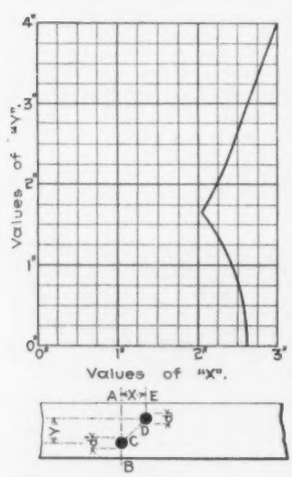


Diagram Giving Minimum Alternate Rivet-Spacing for ⅞-In. Rivets.

Minimum distance c. to c. three diameters, one rivet hole out for net section.

Arch. R. Eldridge.

Chief Engr.'s Office, C., B. & Q. Ry.,
Chicago, Ill., Nov. 11, 1901.

A "Dinner Specification."

Sir: On the evening of Nov. 20 the engineering force of the Weston Aqueduct Department of the Metropolitan Water-Works gave a dinner to the contractors and their representatives engaged upon the Weston Aqueduct, the event marking the close of the more active construction work for the season, and a partial disbandment of the engineering force.

I enclose herewith one of the "contracts" for the dinner. This is interesting as being almost an exact facsimile in miniature of the contracts prepared by the board for work in the Weston Aqueduct department—the color of the covers, style of type, etc., are the same, and the contract is numbered and bears the State seal (although not the official one as now employed).

Very truly yours, C. W. S.

Belmont, Mass., Nov. 22, 1901.

(We reprint the "contract" and "specifications" below.—Ed.)

CONTRACT.

The contract is for the construction of better acquaintance and the maintenance of good fellowship among the engineers and inspectors, and for re-enforcing and rebuilding the pleasant relations existing between the contractors, parties of the first part, and the engineers and inspectors, parties of the second part.

All the work under this contract shall be done to the satisfaction and tastes of each individual, who shall also determine the amount and kinds of material he shall use in the concrete mixture to fill his interior cavity; the amounts to be limited only by the size of this cavity, and the kinds by the following specifications:

SPECIFICATIONS.

OYSTERS ON HALF SHELL.
Not to exceed two inches in their largest diameter.

CONSOMME. ITALIAN PASTE.
To be clean and sharp, and free from loam and pebbles.

OLIVES. CELERY.
Are included in the cost of excavation.

FRIED SMELT.
SAUCE TARTARE. POMME DUCHESSE.
Spread in 3-inch layers and allowed to stand 6 weeks.

ROAST YOUNG TURKEY, OYSTER DRESSING.
CRANBERRY SAUCE.
GREEN PEAS. MASHED POTATOES.
Delivered in such packages as may be approved by the Contractor.

PUNCH AU ROMAINE.
The ingredients to be mixed in the proportion of 1 to 1, wet.

FILLET OF BEEF, CHAMPIGNONS.
BROWNED SWEET POTATO. FRIED BANANAS.
To be laid with close joints neatly struck and pointed.

LOBSTER SALAD.
To set 60 hours before centers are drawn. No mules allowed to pass over.

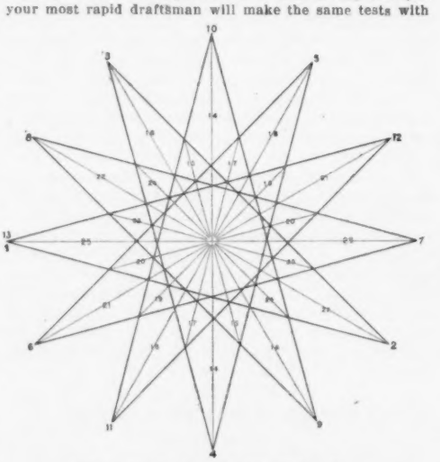
SUNSET PUDDING. CUSTARD SAUCE.
VANILLA ICE CREAM.
ASSORTED CAKE. NUTS AND RAISINS.
This material may be used as back-filling on sides and top.

TOASTED CRACKERS.
Of the best quality and hard burned.

CAFE NOIR.
To be applied as a thin wash on the interior surfaces.

A Test of Tetrangles and Double Triangles.

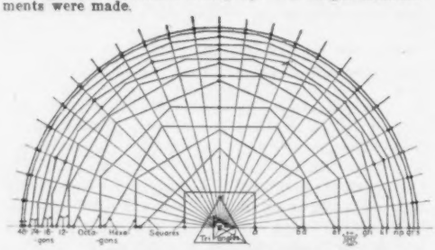
Sir: I think you may be interested in the enclosed blueprint of time tests of my "tetrangle" and "double triangle." You will appreciate their time-saving value, if your most rapid draftsman will make the same tests with the two "dear old triangles" in place of the "double triangle," and with the three triangles in place of the "tetrangle," all the other conditions being as nearly the same as possible. Truly yours,



Time Test of a Double Triangle.

(The original drawing was 8½ ins. in width.)

On bond-paper, fastened by thumb-tacks to a drawing-board 18 × 23 ins., all the lines of this figure were pencilled in 10 minutes (in the order of the numbers) by using only a 24-in. T-square, a wedge-pointed 6H lead pencil, and a 14-in. celluloid double triangle which had been in use eight years without truing up. No length measurements were made.



Time Test of a "Tetrangle."

(The original drawing was 8½ ins. in width.)

On bond-paper, fastened by thumb-tacks to a drawing-board 18 × 23 ins., it took 54 minutes to draw the 25 radial lines, to measure only the distances from c to the other lettered points by scale and to the other circled points by compasses, and to construct the 16 regular half-polygons—by using only a 24-in. T-square, a wedge-pointed 6H lead pencil, and a 14-in. rubber tetrangle which had been in service 4½ years without truing up.

L. F. Rondinella, Professor of Drawing,
Central Manual Training School.

Philadelphia, Nov. 1, 1901.

(Prof. Rondinella's double triangle differs from the ordinary right triangle in having a "hump" on the hypothenuse side, so that its outline is four-sided and not triangular. The upper part of the hypothenuse makes an angle of 45° with the vertical, and the lower part makes an angle of 60° with the base. The "tetrangle" is similar, but has a more pronounced "hump," as the upper part of the hypothenuse makes an angle of 60° with the vertical and the lower part an angle of 75° with the base. The draftsman has a large variety of angles ready to hand which are useful in laying off work. The tests are shown and described in the accompanying cuts.—Ed.)

Formula and Diagram for Solving Spillway Problems.

Sir: The article entitled "Drainage Areas and Spillways," by Mr. E. Sherman Gould, M. Am. Soc. C. E., in Engineering News of Nov. 14, contains a formula for the determination of the time required for the water in a reservoir to rise to a given height above the level of the spillway. On account of the practical importance of this question a brief discussion of the problem may be of interest, particularly as I do not find it treated in any of the works on hydraulics with which I am acquainted.

The problem may be stated as follows: The spillway of a reservoir whose area is A sq. ft., is of dimensions L, H; such that it will discharge a run-off of Q cu. ft., entering the reservoir per second, when the depth of water over the spillway reaches H; or expressing this condition by an equation, $c\,L\,H^{3/2} = Q$, in which $c = \frac{2}{3} m \sqrt{2g}$; m being the coefficient for crest contraction. To find the time required for the water to rise from the bottom of the spillway to any height, h.

The formula given in Mr. Gould's article before mentioned is,

$$(1)\quad T = \frac{2\,h\,A}{Q}\left[\frac{1}{2} + \frac{k}{5} + \frac{k^2}{8} + \ldots + \frac{k^r}{2+3r}\right] = \frac{2\,A}{(Q\,c^2\,L^2)^{\frac{1}{3}}}\left(\frac{h}{H}\right)\left[\frac{1}{2} + \frac{k}{5} + \frac{k^2}{8} + \ldots + \frac{k^r}{2+3r}\right]$$

in which

T = time in seconds;

$$k = \frac{c\,L\,h^{\frac{3}{2}}}{Q} = \left(\frac{h}{H}\right)^{\frac{3}{2}}$$

For the smaller values of h this series converges rapidly, but as h approaches H and k therefore approaches unity the convergence is slower and the computation of T becomes more laborious.

For this reason, and also generally on account of its closed form, the following formula is perhaps to be preferred:

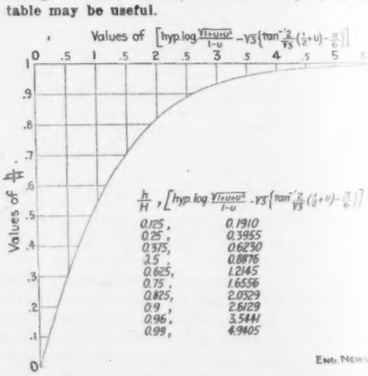
$$(2)\quad T = \frac{2\,A}{3\,(Q\,c^2\,L^2)^{\frac{1}{3}}}\left[\text{hyp. log.}\frac{\sqrt{1+u+u^2}}{1-u} - \sqrt{3}\left\{\tan^{-1}\frac{2}{\sqrt{3}}\left(\frac{1}{2}+u\right) - \frac{\pi}{6}\right\}\right];$$

in which

$$u = \left(\frac{c\,L\,h^{\frac{3}{2}}}{Q}\right)^{\frac{1}{3}} = \left(\frac{h}{H}\right)^{\frac{1}{2}}.$$

For h = H, u = 1, and T is + ∞, as it ought to be from physical considerations. For all values of h less than H, however, T is finite, and h may be taken as near H as may be desired.

In order to facilitate the calculation of the times corresponding to different values of h the accompanying curve and table may be useful.



The vertical line, 0 — 1, represents the values of $\frac{h}{H}$, and the horizontal lines included between 0 — 1 and the curve represent the corresponding values of

$$\left[\text{hyp. log.}\frac{\sqrt{1+u+u^2}}{1-u} - \sqrt{3}\left\{\tan^{-1}\frac{2}{\sqrt{3}}\left(\frac{1}{2}+u\right) - \frac{\pi}{6}\right\}\right]$$

These values substituted in equation (2) give the time in seconds.

Another expression for T, which admits of a simple approximate evaluation, is given in the following formula, suggested to the writer by Prof. R. S. Woodward, of Columbia University:

$$(3)\quad T = \frac{4\,A}{3\,(Q\,c^2\,L)^{\frac{1}{2}}} \int_0^x (\sin x)^{\frac{1}{2}} \sec x\, dx;$$

in which

$$x = \sin^{-1}\sqrt{\frac{c\,L\,h^4}{Q}} = \sin^{-1}\left(\frac{h}{H}\right)^{\frac{2}{3}}.$$

Now this is plainly seen to be infinite where the integral is carried over the entire range, $x = 0$ to $x = \frac{\pi}{2}$, and, as above mentioned, this result is justified by physical considerations. But if the integral is carried from $x = 0$ to any value of x less than $\frac{\pi}{2}$ the result will be finite and it will give the corresponding value of h. The value of the integral in (3) is easily computed by mechanical quadrature.

To illustrate the use of formula (2), the following numerical example may be taken:

A = 15,000,000 sq. ft.; Q = 15,000 cu. ft. per sec.:
L = 260 ft.; c = 3.2.
H = 8.19;

$\frac{h}{H} = 0.25$, h = 2.0475 ft., T = 2,160 secs. = 0.6 hrs.

$\frac{h}{H} = 0.5$, h = 4.095 " T = 4,846 " = 1.35 "

$\frac{h}{H} = 0.75$, h = 6.1425 " T = 9,045 " = 2.51 "

$\frac{h}{H} = 0.999$, h = 8.18181" T = 39,546 " = 10.99 "

Since writing the above my attention has been called to the fact that Mr. Frizell has solved this problem in his "Water-Power," deducing a formula which is the same as my equation (2) above, with the exception that instead of specific values of h and H, I have used the ratio $\frac{h}{H}$ and have thus been enabled to compute the above general curve for the variable factor of the second member.

It will be noticed that in the above formulæ and also in Mr. Frizell's formula the assumption has been made that the area of the reservoir is constant. This assumption is, however, never strictly true and in cases where the slope of the banks is very flat and the rise of the water level considerable, the variation in the areas corresponding to different values of h may be very large. This may be partially provided for by making A in the above formulæ the average area of the reservoir between h = 0, and h = H. A more correct solution may perhaps be obtained, however, by the following formula:

Letting,

A_1 = area of reservoir in sq. ft. at elevation of bottom of spillway.

P_1 = perimeter of reservoir, exclusive of dam, in ft. at same elevation.

i = average angle of inclination of the banks of the reservoir to a horizontal plane.

Then, A = area of reservoir corresponding to any value of h, may be expressed as follows:

$A = A_1 + D\,h + D^1\,h^3$, in which

$D = P_1 \cot i$

$$D^1 = \frac{\cot^2 i}{2}\,\pi$$

The time in seconds will then be given by the formula:

$$(4)\quad T = \frac{2}{3\,Q^{\frac{1}{3}}\,c^2\,L^2}\left[\left(A_1\,(c\,L)^{\frac{1}{3}} + D\,(Q\,c\,L)^{\frac{1}{3}}\right)\text{hyp. log.}\,\frac{\sqrt{1+u+u^2}}{1-u} - \left(A_1\,(c\,L)^{\frac{1}{3}} - D\,(Q\,c\,L)^{\frac{1}{3}}\right)\sqrt{3}\left\{\tan^{-1}\frac{2}{\sqrt{3}}\left(\tfrac{1}{2}+u\right) - \frac{\pi}{6}\right\} - D^1\,Q^{\frac{1}{3}}\left\{\text{hyp. log.}\,(1-u^3) + u^3\right\} - D\,(Q\,c\,L)^{\frac{1}{3}}\,(u)\right]$$

for i = 90°; D = 0, and $D^1 = 0$, and (4) reduces to (2).

E. Ludlow Gould, C. E.

Yonkers, N. Y., Nov. 14, 1901.

The Sanitary Protection of the Water Supply of Baltimore, Md.

Sir: In reading your editorial note in Engineering News of Sept. 26, on the general attitude of the authorities in American cities towards protecting their water supplies from pollution and preventing typhoid fever epidemics, I note your statement that "nearly all the attempts thus far made to prevent water pollution in America have stopped short with the enactment of laws by the various state legislatures and the formulation of rules relating to specific drainage areas by a few State Boards of Health." As the methods which we have adopted in this city to attempt to prevent the pollution of our water supply make us somewhat of an exception to the above rule, a description of these methods may be of some interest to your readers.

We have had in this state for a number of years somewhat stringent general laws and State Board of Health regulations with relation to the pollution of public water supplies. Previous to about a year ago a rather desultory inspection of the watersheds of our sources of supply was made. This inspection was first begun about 1880, when the Gunpowder River supply was introduced. Up to 1896 it was done by one man, under the direction of the water department. From 1896 to about 1898 the inspection was done by one or two men under the direction of the city health commissioner. From 1898 to March, 1900, when I took charge of the water department, the work of inspection was done by five men under the control of the department. These inspectors simply visited the various properties on or near the banks of the streams in the watershed, served notices like the enclosed blank on the property owner,* and endeavored by argument and persuasion to have the nuisance abated. Some abatements were accomplished by this method, but most of the worst cases of pollution still remained.

I found that the work of inspection had not been systematically done, and that the records of inspections and abatements were inaccurate, and shortly after taking charge of the department, in March, 1900, I reduced the force of inspectors to two men and started them on a systematic inspection of the watershed to get a record of every property on the banks of all streams and of all other properties the drainage from which could possibly get to the streams.

All our water comes from two sources, Jones's Falls and the Gunpowder River. The former has a watershed of about 40 sq. miles and the latter has a watershed of about 260 sq. miles. This territory is equally divided between the two inspectors and regular routes are laid out. Each inspector is provided with books of blank record slips like the enclosed (reproduced, as filled in, herewith.—Ed.), in which to enter his notes with regard to each property. These slips, as soon as filled out, are sent in to the office, and are there entered into a book in which is kept an accurate record of all data and proceedings with relation to each case. This book has the following headings: "Location," "No. of Inspection," "Owner," "Occupant," "Character," "Condition," "Reported by," "Date Reported," "Date Notified to Abate," "Notice Served By," "Abatement Accomplished," "Abatement Reported By," "Date of Legal Proceedings," "Particulars of Legal Proceedings," "Remarks."

SAMPLE REPORT SLIP, SANITARY INSPECTION BALTIMORE WATER SUPPLY.
(Original measures about 5 × 7 ins.)
(COPY.)

(B.) Baltimore, Jan. 23, 1901.
Arrived White Hall. Time, 11:36.
Left do. Time, 2:07. Mileage, 54.
Location of Property—Left, on Little Gunpowder; right, on N. C. Ry., at White Hall.
Owner—Samuel Black.
Occupant—Do. P. O., White Hall.
Condition—Bad. House drainage (kitchen, closet and bath) to stream flowing into Little Gunpowder.
"A" report bad.
Examined and surveyed.
Returned Baltimore. Time, 3:12.
(Signed.) C. Louis Cross, Inspector.

The inspectors also have with them printed copies of the general laws of the State and State Board of Health regulations for the Baltimore supply, like the enclosed (reprinted below.—Ed.). The first step in attempting to secure abatements is for the inspector to present the owner of the property causing the pollution with one of each of these slips, explain what improvements we would like to have made, and try by persuasion to get the owner to make the improvement.

Formerly the blank notice, on the back of which are the state laws with relation to pollution, was filled out and served on the property owner. In no case, however, where this notice was served and where the abatement was not made within 15 days was any prosecution attempted. This weakened the force of the notice, and consequently the city's position in attempting to secure abatements. These notices are not now filled out and served until all argument and persuasion has failed and we have all data prepared to take up legal proceedings against the property owner.

Our first general inspection, covering the whole watershed, showed about 1,600 properties so situated as to permit of drainage reaching some stream. Of these about 310 were put down as nuisance cases. Of these 310 nuisance cases about 80 abatements were secured by the inspectors by argument and persuasion; some of these only after repeated visits.

In each case of pollution where this method fails to secure an abatement a survey of the property is made, detail plans are prepared showing the exact condition on the property and what we suggest for improvement, and the matter is taken up by direct communication from the chief engineer's office. In order to facilitate this work, designs were prepared showing an arrangement for house drains, barn yards, hog pens and privies which would abate the nuisance in the most economically effective manner, as shown on the large blue print enclosed (reproduced herewith.—Ed.) Also a standard form of property plat and letter of notification was adopted. A copy of this letter, one of each of these drawings and copies of the State laws and State Board of Health regulations are sent to the property owner. This method has also accomplished some abatements.

In all cases where the above methods fail to secure an abatement we propose to enter suit against the owner of the property through the city law department. Data is now ready for the first of such suits, comprising analysis of the water in the stream immediately at the point of discharge of the drain, taken when the drain was actually discharging, copies of all inspection reports and correspondence relating to the case, and a plan of the property, showing the actual conditions existing.

There are three or four small settlements in our watersheds ranging in population from a few hundred to about 2,000. The properties in these places are not handled separately, but the settlement is dealt with as a whole. We prepare for each settlement a complete sewerage system, which will effectually render the effluent harmless with the least possible expense. This plan is presented and explained to the town or county authorities. This has been done so recently, however, that it is not possible at this time to state what the outcome will be. It is quite probable that the city may compromise with these settlements, offering to pay half the expense of these sewerage systems provided the town or county authorities will install them.

In the fall of the year, when typhoid fever is prevalent, our inspectors are instructed to make every effort to get word promptly of each case in the watersheds. As soon as a case is located an immediate inspection of the property is made to determine if any local conditions are responsible for the sickness, and to see that the excretion is properly disinfected and buried.

Alfred M. Quick, Water Engineer.

Baltimore, Md., Oct. 1, 1901.

*The notice simply declared the existence of a nuisance, and stated that a prosecution would follow it if it was not abated in 15 days.—Ed.

(We reprint below the extract from the Maryland statutes, and also the rules for the protection of the Baltimore water supply, as formulated by the State Board of Health.—Ed.)

AN ACT TO PREVENT THE POLLUTION OF STREAMS, WELLS, SPRINGS AND OTHER SOURCES OF WATER SUPPLY IN THE STATE OF MARYLAND.

(Chap. 6, Laws of 1886.)

Art. 27, Sec. 277.*—If any person shall put, or cause to be placed, any dead animal, or part of the carcass of any dead animal, or any decayed or filthy animal or vegetable matter, into any stream, or the tributary of any stream, well, spring, reservoir, pond or other source from which water or ice is drawn, taken or used for drinking or domestic purposes, or shall knowingly suffer any sewage, washings or other offensive matters from any privy, cesspool, factory, trades' establishment, slaughter house, tannery, or other place, over which he shall have control, to flow therein, or into any drain or pipe communicating therewith, whereby the water supply of any city, town, village, community or household, is fouled or rendered unfit for drinking and domestic purposes, he shall be guilty of a misdemeanor, and shall upon conviction thereof in a court of competent jurisdiction, be fined not more than two hundred dollars for every such offence; and after reasonable notice, not exceeding fifteen days, from the State Board of Health, or any local sanitary authority, to discontinue the act whereby such water supply is fouled, a further sum of not more than fifty dollars for every day during which the offence is continued.

902. If any person shall wilfully pollute the water in any lake, dam, reservoir, line of conduit, water pipe, gate house, or other work constructed or used for supplying the city of Baltimore with water, by swimming, bathing or washing therein, or by washing, or causing to be washed therein, or so near thereto as to pollute the water therein, any clothes, the skin of any dead animal, or any impure, fetid or noxious animal or vegetable matter, or shall throw or cause to be thrown therein, or so near thereto as to pollute the water therein, any impure, fetid or noxious animal or vegetable matter, the person so offending shall forfeit and pay a sum not less than five nor more than fifty dollars for each offence.

903. If any person shall erect, or cause to be erected, any privy, hog pen, bleaching or dyeing establishment, or other thing, over any lake, dam, reservoir, line of conduit, water pipe, gate house or other work constructed or used for supplying the city of Baltimore with water, or so near thereto as to pollute or discolor the water therein, the person so offending shall forfeit and pay a sum not exceeding fifty dollars, and the further sum of ten dollars for each and every day the same shall remain after notice to remove same shall have been given.

RULES OF THE STATE BOARD OF HEALTH IN

*Code of Public General Laws.

REFERENCE TO THE POLLUTION OF THE PUBLIC WATER SUPPLY OF THE CITY OF BALTIMORE.

At a meeting of the State Board of Health held on June 29, 1902, at the office of the board, the following rules and regulations for the protection of the public potable water supply of the city of Baltimore were made, ordained and established, pursuant to Chap. 6 of the Laws of 1886 (Art. 27, Sec. 277, Code of Public General Laws), entitled "An Act to prevent the pollution of streams, wells, springs and other sources of water supply;" and in accordance with Sec. 5, Chap. 622, of the Laws of 1890, which clothes the State Board of Health with authority to "make such rules and regulations respecting nuisances, sources of filth and causes of sickness as the said board shall judge necessary for the protection of the public health."

NUISANCES NEAR SPRINGS, STREAMS OR WATER-COURSES.—I. No privy, or place for the deposit or storage of human excreta, shall be constructed, located or maintained within one hundred (100) feet of any lake, pond or reservoir used in connection with the water supply of the city of Baltimore, or within fifty (50) feet of the precipitous bank of any spring, stream, water-course or ravine, the water from which, when running, flows eventually into such lakes, ponds or reservoirs, or into any water main or service pipe of the Baltimore city water-works; and no privy vault, pit or cesspool, or non-transportable receptacle of any kind for the reception or storage of human excreta shall be constructed, located or maintained within three hundred (300) feet of any lake, pond or reservoir used for the storage of potable water for the city of Baltimore, or within two hundred (200) feet of the precipitous bank of any spring, stream or water-course, tributary to said lakes, ponds or reservoirs.

II. Every privy, or place for the deposit of human excreta, which is constructed, located or maintained between the aforesaid limits of one hundred (100) feet and three hundred (300) feet of any lake, pond or reservoir, or within the limits of fifty (50) feet and two hundred (200) feet of the precipitous bank of any spring, stream or water-course tributary to such lakes, ponds or reservoirs, and from which the said excreta are not at once removed automatically, by means of suitable water-tight pipes or conduits to some proper place of ultimate disposal to be approved by the State Board of Health, shall be arranged in such manner that the solid excreta shall be received and temporarily maintained in suitable vessels or receptacles, which shall at all times be maintained in an absolutely water-tight condition and which will admit of convenient removal to some place of ultimate disposal, the liquid parts to be so purified by filtration or otherwise as to afford, in the judgment of the State Board of Health, ample security against pollution of any spring, stream, water-course, ravine, canal or ditch, from which water, when running, flows eventually into any lake, pond, reservoir, water main or service pipe of the Baltimore city water-works.

III. The owner or occupant of premises having privies with such receptacles shall cause the contents to be removed and the receptacle to be cleaned as often as it is necessary to keep the privy in such sanitary condition that no pollution of the soil shall occur; and the contents of such receptacles shall be disposed of in such a manner that they cannot be washed into any spring, stream, water-course, ravine, canal, ditch or well on the watershed draining into the water supply of the city of Baltimore, either over the surface or through the subsoil.

IV. If, owing to the porous nature of the soil, the height and flow of the surface or subsoil waters, the steepness of the slopes, or other conditions of the locality, it shall be the judgment of either the State or City Board of Health, that the excremental matter from any privy or drain may be washed on the surface or through the soil into said lakes, ponds or reservoirs, or into any spring, stream or water-courses tributary to them; then, upon due notice to the owner or occupant of the premises from which such discharge comes, the aforesaid distances shall be increased respectively to such other limits as shall appear necessary to the State Board of Health.

HOUSE-SLOPS, WASTE WATER AND OTHER SEWAGE.—V. No sewage, sink-wastes, house-slops, bath-water, or water in which clothes have been washed or rinsed, nor any other polluted water shall be discharged or thrown into any spring, stream, water-course, ravine, canal or ditch from which water, when running, flows eventually into the water supply of the said city; nor shall any such polluted waters be thrown upon the ground or allowed to pass into the soil where they may pollute the water supply of the city. Neither clothing, animals, nor anything which pollutes water shall be washed in any spring, stream or water-course which eventually flows into the said water supply, nor shall any bathing or swimming pool be constructed, located or maintained on the line of or in connection with such springs, streams or water-courses, unless in the judgment of the State Board of Health the waste liquids polluted with putrescible or deleterious organic matters from any of the operations above indicated shall be sufficiently purified by filtration or otherwise to render them innocuous.

GARBAGE AND REFUSE.—VI. No garbage or refuse shall be thrown into any lake, pond or reservoir connected with the city water-works, nor into any spring, stream, water-course, etc., tributary to the water supply of the city; nor shall any such substances be placed where they may be washed into said water supply.

ANIMAL MANURES.—VII. No stable, barn-yard, pig pen, hog or cow yard, hen house, hitching [illegible] place for horses or cattle, or other place where animal manure accumulates, shall be so constructed [illegible] maintained, that the manure or leachings [illegible] wash into any spring, stream, water-course, [illegible] or ditch from which water, when running, [illegible] ally into the water supply of the city of Balt[illegible]

ANIMAL AND VEGETABLE MATTERS.—[illegible] No living or dead animal, bird, fowl or dead fish, [illegible] thereof, nor any filthy or impure matter, nor [illegible] fruit, vegetable substances, leaves, saw-dust, [illegible] wastes, or any such matters, shall be thrown into or placed within two hundred (200) feet of any [illegible] reservoir, spring, stream or water-course [illegible] or furnishing any part of the water supply of [illegible] Baltimore.

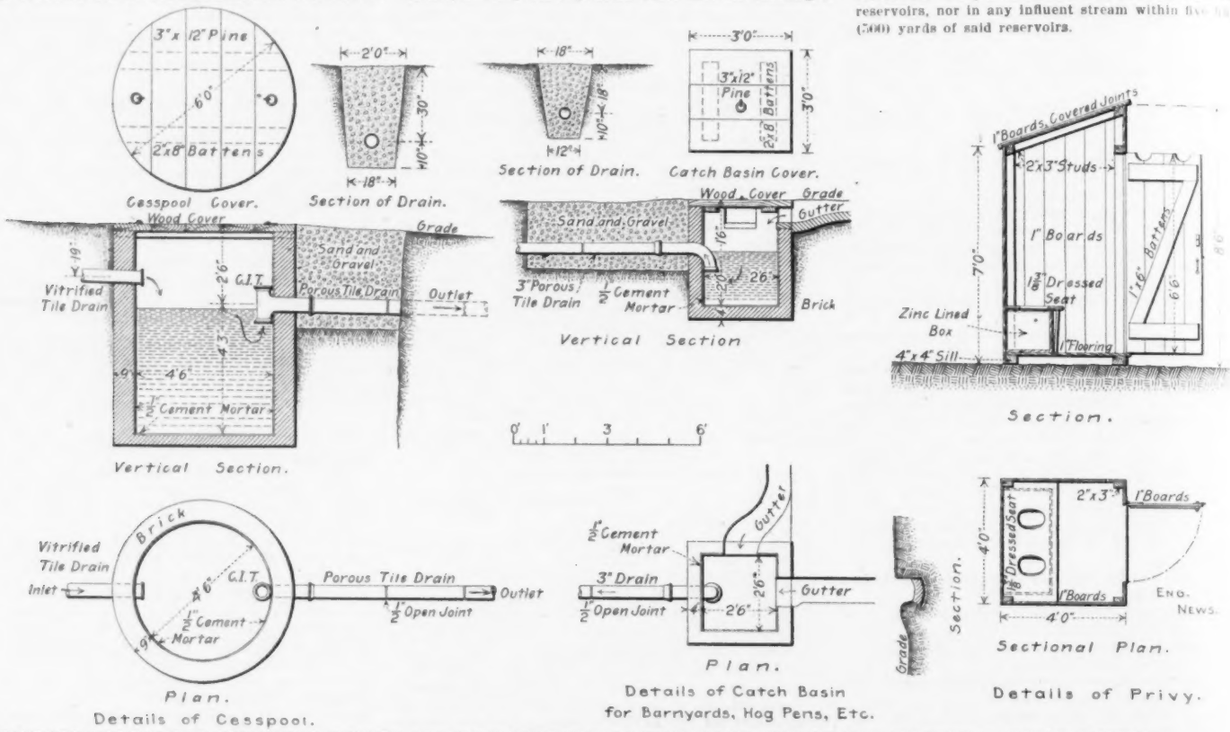
MANUFACTURING WASTES.—IX. No waste products, putrescible matters or polluted waters, from any [illegible] house, creamery, wine or beer vaults, cider [illegible] distilleries, breweries, tanneries, saw mills, or other manufactories, shall be thrown into any lake, pond [illegible] spring, stream, water-course, ravine, canal or [illegible] from which water, when running, flows into the water supply of the said city.

WASHING ANIMALS, BATHING, ETC.—X. No sheep or other animal shall be washed in the city reservoirs, nor in any influent stream within three miles of such reservoirs; nor shall any diseased animal be washed in any spring, stream or water-course tributary to said reservoirs. No person shall bathe, swim or wash in said reservoirs, nor in any influent stream within five hundred (500) yards of said reservoirs.

GRAVE YARDS AND CEMETERIES.—XI. No interment shall be made in any grave yard, cemetery or other place on those portions of the watershed of Jones's Falls, Roland Run and the Gunpowder River now used for the water supply of the city of Baltimore, within one thousand (1,000) feet, horizontal measurement, of the high water mark in any lake, pond or reservoir, or within seven hundred (700) feet, horizontal measurement, of the high water mark or precipitous bank of any spring, stream, water-course, ravine or drain tributary to the water supply of the city of Baltimore; and this distance may be extended, when deemed justifiable, by the State Board of Health, or by the local sanitary authorities of Baltimore city.

MANAGEMENT OF THE RESERVOIRS.—XII. Sec. 1. Said reservoirs shall not be unnecessarily drawn down during the warm weather, but shall be kept as deep and as nearly at a uniform level as practicable, to prevent the pollution of the water with dead organic matter.

Sec. 2. No public filter or screen shall be used when in a filthy condition and liable to pollute the water in the city mains; and no filter or screen shall be used at the head of the main which cannot be constantly examined and cleaned.



STANDARD DESIGNS FOR CESSPOOLS, PRIVIES AND CATCHBASINS IN THE DRAINAGE AREA OF THE BALTIMORE WATER SUPPLY.

Alfred M. Quick, Assoc. M. Am. Soc. C. E., Water Engineer.

Note.—Sewage carried from house to cesspool through a 4-in. vitrified tile drain. Overflow pipe from cesspool shall be 4-in. porous tile drain laid with a gradual fall of 1-in. in 40 ft., with ½-in. open joints. Overflow pipe from cesspool shall be run through a ditch filled with sand and gravel, of the dimensions shown. Overflow shall consist of a cast-iron T, built in wall of cesspool at the depth indicated; and porous tile drain shall connect with same and continue through ditch. A 3-in. cast-iron ¼-in. bend shall be built in wall of catchbasin and a 3-in. porous tile drain to connect with same and run through ditch. Overflow pipes placed in ditches as shown here, and packed around with sand and gravel. Ditches to run from cesspool to stream. Pipe to stop within 50 ft. of stream.

The Fairhaven Water Tank Failure.

Sir: In reading the account of the "Failure of the Elevated Water Tank at Fairhaven, Mass.," in your issue of Nov. 21, I am particularly struck with one defect in its construction which is not mentioned.

I refer to the conical form of the bottom, which is not the equilibrium form for which the metal is subject to tension of equal intensity.

Your account indicates that "the failure was primarily due to a rupture in the bottom of the tank at the junction between the spherical-shaped plate and the inner-ring plates connected to it." That is just the place where the rupture would theoretically first occur in a conical bottom. The other fractures appear to have been caused more by buckling after the fracture started than by pure tension.

As there are other tanks in existence with conical bottoms, the same kind of failure may happen in them, unless the bottoms are better proportioned than was the case in the tank at Fairhaven.

G. L.

New York, Dec. 2, 1901.

Sir: I am very much interested and concerned over the failure of the elevated tank with conical bottom, illustrated and described in your issue of Nov. 21.

I have designed and had similar structures built since 1892, in Canada, and hold the Canadian Patent No. 42,233, and so far have had no signs of trouble, although my sizes have not exceeded 20 to 25 ft. diameter × 40 ft. high, all with the flat annular plate, which rests on the substructure and connects the shell with the conical bottom.

In my designs I have invariably preferred and adopted the flanging of the flat bottom plate upward and riveting same to the shell as in Fig. 1.

Most of the structures for supporting the tanks in my designs have been masonry, although not all.

I have always felt that it was most important to have the inner part of the flat annular base plate strongly supported to withstand the resultant of strains downward and outward.

Any weakness at this point of support would undoubtedly cause yielding, tearing and finally bursting.

I should like very much to see this subject thoroughly investigated and a correct analysis made as to the strains existing at all points, with a view to determine what really is the safe and proper construction for such a design which will be at the same time simple and economical.

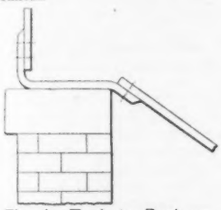


Fig. 1. Tank to Rest on Masonry Tower.

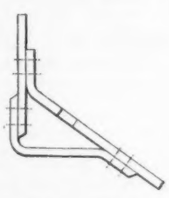


Fig. 2. Proposed Form of Joint.

Detail of Joint Between Curved Bottom and Cylindrical Sides of Elevated Tank.

I am inclined to think that the failure of the Fairhaven tank was caused partly by the tearing at the junction of the flat plate and the conical plate, due to a lack of proper support, the result likely of the circular girders slipping and being forced outward, as there does not appear to have been any rigid connection to the girder to keep them in place underneath the flat bottom portion and close up to where the conical plating begins.

I feel sure that the defect in design and whole trouble is just at this point, and that the problem can easily be solved by some simple change in the detail; for example, by carrying up the conical bottom and attaching it direct to the shell, still preserving the present simple feature of flat annular base plate as in Fig. 2. Still allowing water to exert its pressure and weight on flat plating. Shall be glad to see this subject investigated and determined.

Yours faithfully, John Galt.

Toronto, Ont., Nov. 25, 1901.

(There is no doubt at all that the manner in which the bottom and sides of the Fairhaven tank were connected is subject to criticism, and that the plan now generally adopted of bringing the bottom right up and riveting it directly to the sides of the tank is a preferable design. It is also well established that there was leakage at this joint in the Fairhaven tank. Others who have examined the tank, as well as our correspondent, therefore, have concluded that this joint was the initial point of failure. Notwithstanding all this, we are still of the opinion that the first break occurred at the joint between the central curved plate of the bottom and the inner ring of plates to which it was riveted. A break at this point would let a jet of water fall to the bottom of the tower, which might well erode just such a hole near the center of the pavement as now exists there, before the whole mass of water was discharged and the tower fell. If the initial break had been at the joint between the bottom and the side, however, as our correspondent supposes, this seam would almost certainly have ripped around far enough to let the whole bottom of the tank and the water on top of it fall almost instantly. This, however, does not agree with the evidence, which is to the effect that the break was not instantaneous, but a small stream came down for a few seconds before the final break-up occurred. Further, even if we suppose the initial break to have been at the joint between bottom and sides, and to have opened slowly at first, such a break would throw a sheet of water to one side, and could not have sent a jet down to the center of the pavement below to erode the hole shown in Fig. 4 of our issue of Nov. 21.

Fig. 3. Another Form of Joint.

Concerning the connection between the bottom and the sides of the tank, suggested by Mr. Galt in his Fig. 2, we may note that a somewhat simpler construction for this connection has been sent us by a correspondent experienced in this class of work and is shown in Fig. 3. We shall be pleased to hear from still others who have had experience with tanks having other types of joints as to what they have found regarding ease of erection, troubles with leakage and facility of calking in the different designs employed.—Ed.)

Sir: I have been very much interested in the account of the Fairhaven water tank failure published in your issue of November 21. I desire to call your attention to some features of the original design and of the modifications of that design made during construction which were not mentioned in your account of the failure, and which it seems to me, whether they did or did not actually cause the failure, may readily have done so. In what I shall say I do not desire to be put in the position of in any way criticizing the engineer who prepared the original designs. The Fairhaven water tower was a pioneer structure of its kind. In most engineering designs some features cannot be calculated and must be designed in accordance with the results of experience. In the case of the Fairhaven tower experience to point out features requiring special attention in the design was lacking. Again, very serious changes (see Engineering News, Nov. 21, 1901), from the original design were made in the construction of the tower, and I consider that these added greatly to the danger of failure. The engineer who designed the structure cannot be held responsible for its failure in my opinion.

In Fig. 1, I have reproduced your sketch (with some additions) showing the methods of supporting the tank at the tops of the posts. Owing to the posts having a batter, the post thrust against the bottom of the circular girder will have an inward horizontal radial component. From the original description of the tower published in Engineering News of Sept. 5, 1895, I judge that the batter was about 1 to 8. With the tank full the horizontal radial component would, therefore, be about 36,000 lbs., as indicated in Fig. 1. No special provision appears to have been made in the design to take care of these radial pressures, except as the lower flange of the circular girder may be capable of withstanding them. In all designs for water towers these forces should be provided for, and usually are provided for by the use of a circular girder with its web horizontal. The company which builds more such structures than any other in the country uses solid plate webs. The writer is acustomed to use a web system for this circular girder composed of angles. Usually this girder is utilized to form the floor of the balcony, which

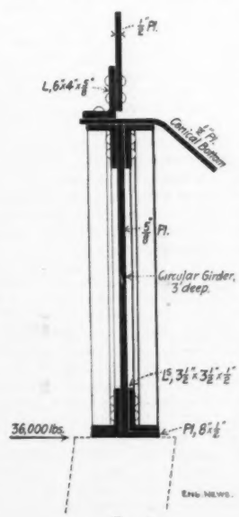


Fig. 1.

I consider a very important feature of water tower designs, as it enables convenient and careful inspection to be made of the portion of the tank which is most liable to failure; namely, the junction of the tank with the supporting posts. In the case of the Fairhaven tank, if we consider the horizontal radial components of the post thrusts to be carried only by the lower flange of the circular girder, and if this lower flange had been made continuous past the posts, a bending moment of 331,000 inch-pounds and a thrust in the line of the flange of 67,000 lbs. would result immediately over each post. Counting the lower flange as composed of two 3½ × 3½ × ½-in. angles, and one 8 × ½-in. cover plate (see Eng. News, Sept. 5, 1895), and also counting in 3½ ins. of the ⅝-in. web plate of the circular girder, the resulting stress on the outer fiber would be 38,400 lbs. compression at the post connection. As built, the the lower flange seems not to have been continuous, and this bending moment would have to be carried by the rivets of the connection between the segments of the circular girder with each other and with the top of the posts. No data of the connection have been published which would enable the resulting stresses upon the rivets to be computed, but under any reasonable assumption it seems probable that they must have all along been stressed nearly to the breaking point whenever the tank was entirely full of water.

As the formulas for the computation of the stresses given above are not widely published, the writer here gives them, crediting them to two students of the Civil Engineering Department of Cornell University (Transactions of the Association of Civil Engineers of Cornell University, 1896).

At any point A in the circular hoop shown in Fig. 2 let the bending moment from the pair of radial forces, P, be called M, the thrust T and the shear J. Then,

$$M = Pr\left(\frac{\sin\varphi}{2} - \frac{1}{\pi}\right); \quad T = \frac{P}{2}\sin\varphi; \quad J = \frac{P}{2}\cos\varphi.$$

In addition to the above critical stresses in the circular girder, it should be observed that if this girder fulfils the purpose for which it was intended, that of transferring the weight of the tank to the posts, it will be subjected to a large bending moment immediately over the posts, of such nature as to cause tension in the upper flange and compression in the lower flange. This compression in the lower flange has to be added to the stresses already given, and in addition it should be noted that each segment of the circular girder would have a tendency to rotate inwards at the top of the post connection owing to the fact that it is not straight between posts. Certainly the circular girder should have been made continuous as provided for in the original plans, and the fact that it was built in segments renders the upper flange incapable of carrying the tension over the posts, and this tension, so far as the friction from the heavy load can do this, would be transferred to the flanged portion of the conical bottom, tending to disrupt it along a radial line.

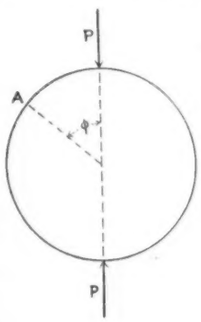


Fig. 2.

The writer does not consider it necessary or even desirable to use a circular girder under the sides of the tank. There is no way of preventing the tank itself from acting as a girder to carry the loads to the posts if we desired, and the writer considers that it ought to be strengthened sufficiently to enable it to do this with safety. The writer would not put any manhole in the lower ring of plates of the tank.

In the case of the Fairhaven tank, the lowest side ring of plates appears to have been made of just about the thickness that good practice would require for a standpipe of diameter and height equal to the tank above this point. Now, the conical bottom at its junction with the sides of the tank is subjected to bursting stresses greater than those in the sides of the tank in the ratio $\frac{1}{\sin\theta}$. Where θ is the angle which an element of the cone makes with a horizontal line. I am unable to tell exactly what θ was in the case of the Fairhaven tank from any published data, but presume that it was in the neighborhood of 45°. If θ equals 45°, the upper ring of plates in the conical bottom was over-stressed about 40% beyond what good practice would indicate as reliable. In addition comes the stress over each post due to the fact that the circular girder was made in segments instead of continuous.

Under the circumstances indicated above the writer does not consider the failure of the tank a matter for surprise. It may readily have happened that the lower flange of the circular girder, after having been repeatedly stressed beyond the elastic limit, may have bent inward at some post. The result would be a redistribution of the stress which would be pretty sure to tear the tank at its weak-

est point, which in this case was the conical bottom. The first indication of failure visible from the ground would be a stream of water escaping from this tear which would be followed by the immediate collapse of the structure. The writer considers this the most probable way in which the failure occurred, but if for some unknown reason the bottom disrupted first, the fact that the circular girder was in unstable equilibrium, so to speak, would lead to the immediate collapse of the structure. The writer considers that the lessons to be drawn from the failure are that in the design of elevated steel tanks:

1. A larger factor of safety should be used for the curved bottom than for the vertical sides of the tank.
2. The lower portions of the vertical sides of the tank should be strengthened to resist the shearing and other girder stresses caused in them by transferring the load to the posts.
3. The junction of the bottom and sides of the tank should be held true to shape and the radial components of the post thrusts should be provided for by a circular girder extending entirely around the tank and having its web system horizontal.
4. A balcony should be provided at the junction of the bottom and sides of the tank, to permit ready inspection of this most important part of the structure.

The writer will add that it is very important that the loads should bear centrally on the posts, or that the stresses due to eccentricity of loading should be amply provided for.

Yours very truly,

A. Marston.

Civil Engineering Department, Iowa State College,
Ames, Ia., Nov. 25, 1901.

The Recent Gathmann Gun Test.

Sir: In your issue of Nov. 21 you have spoken of the failure of the Gathmann guncotton shell in the recent tests of the same at Sandy Hook, under a head which implies that it was the 18-in. torpedo gun from which the shell was fired that failed, instead of the shell itself. I have observed also that most of the press notices of these tests speak of them as the failure of the Gathmann torpedo gun, so-called. The gun did not fail. On the contrary, this big 18-in. gun may be considered a decided triumph in ordnance construction.

Although this gun was built under a Congressional appropriation secured for the purpose of making the tests of the Gathmann guncotton shell which have just been concluded, still the gun itself embraces no patentable novelty; neither was Mr. Gathmann the first to propose such a weapon for the purpose of throwing large masses of high explosives for the destruction of war vessels and fortifications. In 1893 the writer proposed a gun of this type, for the purpose of throwing high-explosive projectiles of similar construction to the semi-armor-piercing high-explosive shells now used by the United States Army in the 12-in. gun, which have scored such wonderful success. Such projectiles used in this 18-in. gun, instead of the thin-pointed non-armor-piercing guncotton shell of Gathmann, would render it a terribly destructive weapon.

It was Mr. Gathmann's idea that the heavily armored belt of a battleship could be crushed in by the sheer force of the blast of guncotton exploded upon its surface without any penetration whatever, and he therefore designed a shell very thin at the point, in order to carry the maximum amount of explosive in the forward end. It was his aim that the long, thin projectile, with its column of explosive, on striking armorplate should mushroom upon it, and when shortened in this way a foot or so, the explosive charge should bear upon an area of the plate greater than the cross-sectional area of the projectile, at which instant he depended upon his fuze to act to detonate the guncotton charge and demolish the plate and its backing.

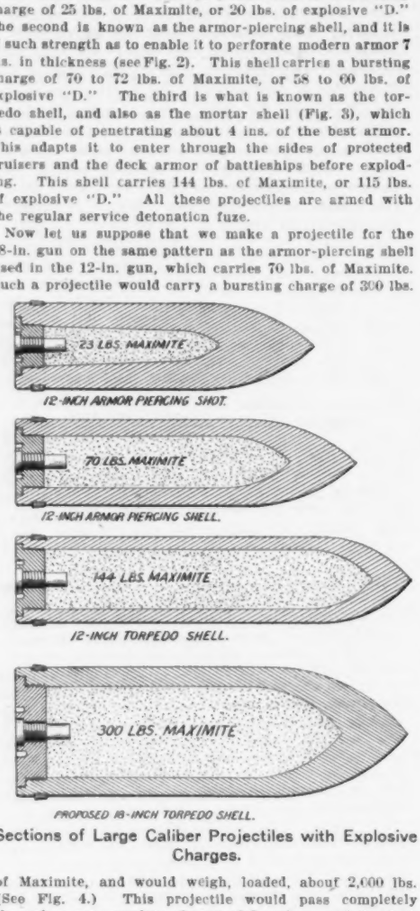
This was not in any sense a competitive trial of gun against gun, but a competitive trial of armor-piercing and semi-armor-piercing projectiles charged with the most powerful explosives known to science and adapted to explode after entering the target, against a shell having a thin collapsible point without any power of penetration whatever, charged with wet guncotton, an explosive of far inferior power, and adapted to explode merely on the surface of the plate. The trial was, in a nutshell, one of interior explosion versus exterior explosion.

In order therefore to correctly judge of the practicability of the big 18-in. gun used in these tests, it will be necessary to compare it with the 12-in. gun under like conditions, both guns firing the same type of projectile and the same explosive.

The 12-in. gun weighs 52 tons, while the weight of the 18-in. gun is 59 tons. There is, therefore, but little difference in weight and the cost of the one is about the same as the cost of the other. An admissible chamber pressure for the 12-in. gun is from 35,000 to 37,000 lbs. per sq. in., which throws a projectile weighing 1,000 lbs. at a velocity of 2,300 ft. per second, representing a muzzle energy of about 36,000 to 37,000 ft.-tons. An admissible chamber pressure for the 18-in. gun is from 20,000 to 23,000 lbs. per sq. in., which will throw a projectile weighing 2,000 lbs., or one ton (twice the weight of the 12-in. projectile), at a velocity of 2,100 ft. per second, representing a muzzle energy of from 51,000 to 52,000 ft.-tons, which is about 50% greater than the muzzle energy of the 12-in. gun. The striking energy of this shell is equal to that required to raise a modern battleship bodily to a height of 5 ft. It represents the striking energy of a ton weight falling a distance of about 10 miles, without making any allowance for the resistance of the air.

There are three high-explosive projectiles used in the 12-in. gun. The first, known as the armor-piercing shot (Fig. 1), is of a strength adapting it to perforate 12 ins. of the best armor. This projectile carries a bursting charge of 25 lbs. of Maximite, or 20 lbs. of explosive "D." The second is known as the armor-piercing shell, and it is of such strength as to enable it to perforate modern armor 7 ins. in thickness (see Fig. 2). This shell carries a bursting charge of 70 to 72 lbs. of Maximite, or 58 to 60 lbs. of explosive "D." The third is what is known as the torpedo shell, and also as the mortar shell (Fig. 3), which is capable of penetrating about 4 ins. of the best armor. This adapts it to enter through the sides of protected cruisers and the deck armor of battleships before exploding. This shell carries 144 lbs. of Maximite, or 115 lbs. of explosive "D." All these projectiles are armed with the regular service detonation fuze.

Now let us suppose that we make a projectile for the 18-in. gun on the same pattern as the armor-piercing shell used in the 12-in. gun, which carries 70 lbs. of Maximite. Such a projectile would carry a bursting charge of 300 lbs.



Sections of Large Caliber Projectiles with Explosive Charges.

of Maximite, and would weigh, loaded, about 2,000 lbs. (See Fig. 4.) This projectile would pass completely through any armorplate of protected cruisers and the deck armor of battleships, to explode inside. In the bombardment of fortifications, it would penetrate deep into earthworks before explosion took place, thereby producing the maximum effect. Employed in the bombardment of cities, such a projectile would be very destructive. Thrown from a sea-coast gun, and striking in the water beside a war vessel, this shell would constitute a veritable submarine mine, and would doubtless be sufficient to sink the vessel. Striking armorplate of from 10 to 12 ins. in thickness, this shell would probably explode while in the act of passing through with a result (except on a vastly larger scale) like that which the 12-in. shell carrying 70 lbs. of Maximite has shown itself capable of producing upon armorplate of such thickness. When such a shell strikes armorplate of a thickness greater than it is adapted to penetrate, it explodes in entering the plate, and when the point is in the act of displacing the metal in its path. The explosion, occurring at this instant, will [illegible] with that of projection from the gun, and for[illegible] onward through the plate, regardless of [illegible] and dispersion of the rest of the projectile, [illegible] ged hole through the armor, while the blast [illegible] sion follows up the shell fragments and the [illegible] the plate, hurling them forward with tremen[illegible] to demolish the cofferdam backing and every[illegible] path.

The Gathmann shell is not a representative [illegible] aerial torpedo, while the torpedo shell of the [illegible] a true aerial torpedo, and a torpedo shell [illegible] for the 18-in. gun which will make it the most [illegible] and the most practical piece of ordnance [illegible] ever made. To accomplish such a result it [illegible] essary for the ordnance department to mak[illegible] service shell for this gun and use in them [illegible] service high explosives and the regular deto[illegible] a combination which has produced such wonde[illegible] during the last year and a half at the Sandy [illegible] ing Grounds, finally scoring such a victory [illegible] in competition with the Gathmann shell which [illegible] been terminated.

The failure of the Gathmann shell is [illegible] against aerial torpedoes of the proper sort, whil[illegible] success of the 12-in. high-explosive projectiles [illegible] veritable aerial torpedoes, is the strongest poss[illegible] in favor of a torpedo gun of a larger [illegible] weight than the ordinary gun, and similar to [illegible] 18-in. gun.

There is no excuse for an aerial torpedo or [illegible] sive shell with a collapsible point and adapted [illegible] only on the exterior of armorplate, for far superior results are produced on armor when shells are made [illegible] armor-piercing, and such shells have the additional advantage that they will penetrate light armored [illegible] deep into earthworks before exploding.

Very respectfully,

Hudson Maxim.

891 Sterling Place, Brooklyn, N.Y., Dec. 2, 1901.

Notes and Queries.

M. H. M., Rondout, N. Y., asks for a formula for making a gelatine pad or hektograph.

The ingredients used are glue or gelatine dissolved in sufficient water to give the mixture the proper elasticity when cold. Glycerine is added to the mixture to prevent it from drying.

REMOVAL OF BACTERIA AND COLOR FROM WATER BY MECHANICAL FILTRATION AT EAST PROVIDENCE, R. I.

By Edmund B. Weston, M. Am. Soc. C. E., M. Inst. C. E.*

In your issue of July 13, 1899, you published the results of a 110 days' initial test of a mechanical filter installed under my direction at East Providence, R.I., by the New York Filter Manufacturing Co.† It may be of interest to your readers to learn what the efficiency of this filter has been during the last 20 months, based upon the results obtained with samples of water collected once a month and analyzed under the direction of the Secretary of the State Board of Health of Rhode Island.

During the initial test, from March 10 to Aug. 2, 1899, the average removal of bacteria during the time that one grain of sulphate of alumina per gallon (containing about 22% of alumina, Al_2O_3) was used, was 99.2%. The average removal of color during the initial test in 1899 was 83%.

Tables are included herewith giving in detail the bacteriological and color data for the 20 months from April, 1900, to November, 1901, inclusive.

*86 Weybosset St., Providence, R. I.

†In our issue of Nov. 9, 1899, we published an abstract of a discussion of a paper on the full five-months' test, read by Mr. Weston before the American Society of Civil Engineer.—Ed.

Removal of Bacteria and Color from Water by Mechanical Filtration at East Providence, R. I.

Date.	Bacteria per cu. cm. In raw water.	Bacteria per cu. cm. In filtered water.	Bacteria per cu. cm. Per cent. reduction.	Color† in Raw water.	Color† in Filtered water.	Color† Per cent. reduction.	Grains sulphate of alumina per gall.
April 11, 1900	600	6	99.00	0.50	0.05	90	0.75
May 1	608	16	97.37	.67	.06	91	0.75
June 6	1,129	62	94.51	.94	.23	76	0.75
July 6	195	36	81.54	.68	.13	81	0.75
August 1	150	4	97.33	.58	.05	91	1.0
September 5	264	4	98.90	.42	.05	88	1.0
October 4	272	1	99.63	.33	.02	94	1.0
November 7	553	3	99.46	.42	.06	86	1.0
December 5	1,157	15	98.70	.71	.08	89	1.0
January, 1901	3,534	25	99.29	.49	.05	90	1.0
February 6	1,178	4	99.66	.43	.05	88	1.0
March 6	40,920	235	99.43	.53	.05	91	1.0
April 3	673	Lost.	.....	.60	.10	83	1.0
May 1	583	0	100.00	.61	.05	92	1.0
June 5	414	76	81.64*	.95	.08	92	1.0
June 20	312	2	99.36	...	...	...	...
July 3	361	17	95.29*	.06	.05	92	1.0
July 17	598	11	98.16	...	...	...	...
August 7	146	1	99.32	.29	.00	100	1.0
September 3	192	2	98.96	.35	.01	97	1.0
October 2	1,426	1	99.93	36	.04	89	1.0
November 4	108	0	100.00	.41	.05	88	1.0

*As these results of June 5 and July 3, 1901, were unusually low, and as there was a question as to whether it was due to the filter or to the collection of samples and laboratory work, it was decided to collect additional samples in these months, the result of which is shown in each instance by the result immediately following.

†The color is expressed in terms of the platinum-cobalt standard.

It can be seen in the tables that the bacterial results of June 5 and July 3, 1901, were unusually low, although the reduction of color was above the normal, and additional samples were collected in each of these months and bacterial results determined as shown in the bacteriolcgical tables.

During the 16 months, from August, 1900, to November, 1901, inclusive, while one grain of sulphate of alumina per gallon was used (which was about the same grade as mentioned above), the average bacterial reduction, including results of June 5 and July 3, 1901, was 99.23%, and excluding the results of June 5 and July 3, 1901, it was 99.... During this period, with the exception of March, 1901, the average number of bacteria per cubic centimeter in the raw water was 700, and in the filtered water, 1.

The average removal of color during the 16 months that one grain of sulphate of alumina per gallon was used was 90%, ranging from 83 to 100%.

During the four months from April to July, 1900, ¾ of a grain of sulphate of alumina per gallon was used, and the average bacterial reduction was 95.26%. For obtaining the best results, ¾ of a grain of sulphate of alumina is not considered sufficient, and therefore as small an amount as ¾ of a grain per gallon has not been used since July, 1900.

The average removal of color for the four months that ¾ of a grain of sulphate of alumina per gallon was used was 83%, ranging from 76 to 91%.

The percentages of reduction mentioned above, while one grain of sulphate of alumina per gallon was used, are very satisfactory, especially the bacteriological results, as the average number of bacteria in the raw water (leaving out March, 1901) was only slightly above 700.

Also the bacteriological results from another point of view are of a high order, as the average number of bacteria in the filtered water, while one grain of sulphate of alumina per gallon was used, did not exceed 24, and leaving out March, 1901, the average number was only 10.

REPORT OF THE COMMITTEE OF THE NEW ENGLAND WATER-WORKS ASSOCIATION ON STANDARD SPECIFICATIONS FOR CAST-IRON PIPE.*

In its consideration of this subject your committee has assumed that it was your intention that its study should cover the design of cast-iron pipe and special castings, as well as the methods of their manufacture, and that its recommendations should include drawings of the pipes and special castings, tables of dimensions, and a list of weights for the different diameters and classes, in addition to specifications of the processes of manufacture and the character of the pipes when completed.

The committee has conceived its duty to be not the recommendation of new processes, radical changes in existing specifications, nor even an unvarying list of weights for different heads or pressures, but rather a codification of the best present practice in design and manufacture in such form that, if used as a standard, pipe can be furnished by the manufacturers and procured by purchasers with more certainty and satisfaction than can be done at present, even with the most perfect individual specifications, and at the same time to be sufficiently elastic to allow, with a minimum of trouble, the incorporation of special ideas in an order for pipes.

It is believed that standard specifications to obtain general acceptance must allow for the personal equation of the user. While the many difficulties attending the present individualistic methods are well known, the committee recognizes the futility of the adoption of a standard, which, although securing uniformity, too closely limits individual freedom of practice.

The specifications recommended will not be wholly satisfactory to those who hope for an instrument which will of itself, without further thought or study, automatically regulate the whole business of securing suitable pipe for use under all conditions. The committee believes, however, that it is practicable to arrange standards in such a manner that no one adopting them will be obliged to depart widely from his own practice, while at the same time many of the difficulties now attending the purchase and use of cast-iron pipes will be avoided.

SOME OF THE DIFFICULTIES OF PRESENT PRACTICE.

FORM AND DIMENSIONS OF PIPES AND CASTINGS.—The variation in form and dimensions of pipes and castings from different foundries, and even in different lots from the same foundry, causes much trouble and expense in pipe laying. Special castings are the most troublesome in this respect, spigots often being too large or thick to allow sufficient lead room in the bell of the pipe, even if they will enter at all without chipping the head. Different classes of pipe often cause trouble in the same way, especially when the different thickness of shell is secured by a change in the outside diameter.

Unless drawings are furnished for special castings (which it is not always practicable to do, especially for small orders), one does not know the length or weight, or even if the castings will come with bell and spigots, or bells all around. Sometimes reducers are sent with bells on the large end and sometimes on the small end. The radii of bends can rarely be ascertained in advance.

Even when drawings are furnished unless an inspector is at the works, the castings are quite as likely to come of some other pattern and weight (not usually lighter), when the alternatives are to use those sent or wait for others to be cast and delivered.

On the other hand, it is clearly impossible for the manufacturer to keep a stock of pipe or specials on hand, when he cannot be sure that any two orders will have the same requirements, even in the simplest details.

The entire lack of system in fixing the weights of pipes is the cause of much trouble and perplexity, the weight cards of the different foundries agreeing no better than the tables of different engineers. The great variety in specifications not only causes trouble in the foundry, but results to the purchaser of pipe not inspected at the works and of pipe in small lots or on quick orders, in the receipt of pipe which, although it may make fairly good work when laid, is nothing more nor less than a job lot of different sorts and sizes, very difficult to lay.

RECOMMENDATIONS.

In an endeavor to simplify and unify the practice in the manufacture and use of cast-iron pipes and special castings, your committee makes the following suggestions, which are embodied in the appended standard specifications of cast-iron pipe, which it recommends to the association for adoption.

DESIGN.

LENGTH.—The standard length of the pipes shall be 12 ft., exclusive of the bell or socket.

DIAMETERS.—For sizes from 4 to 18 ins., inclusive, the inside diameter of pipes of a given nominal size shall be varied in accordance with the varying thickness used for different pressures or conditions, and the outside diameter for all classes or weights shall be uniform. For sizes larger than 18 ins., there shall be three sizes for the outside diameter of each nominal diameter.

It is feared that if one outside diameter were adopted for all classes in the larger sizes of pipes, it would cause so much difficulty in connecting future pipe to that already laid, and in making repairs, that it would be a serious obstacle to the adoption of the standard. It is also believed that the use of more than one outside diameter will not cause so much trouble in the larger sizes as in the smaller ones.

The committee has endeavored to suggest outside diameters for the several sizes of pipes that will conform as nearly as possible in sizes in general use at the present time, and, also, those which will give the full interior diameter for the thickest pipe in common use. The outside diameters proposed by the committee are given in Table No. 1 of the specifications.

DEPTH AND JOINT ROOM OF BELLS.—There is undoubtedly considerable variation in present practice in the depth of bells. The committee is of the opinion that good results are secured with all depths used, and that an exact depth of bell is not an essential matter to any engineer. Therefore, as the use of a standard bell will do much to simplify the casting of pipe, it recommends the adoption of the list of depths given in Table No. 1. These depths are believed to conform very nearly to the average practice.

Although the practice regarding variation in joint room is not as great as in the depth of the bells, the committee was influenced by the same reasons to recommend a uniform list of thickness, which is also found in Table No. 1.

If Table No. 1 is adopted as the standard and adhered to, the result will be that every pipe and special casting under 20 ins. in diameter will fit every other pipe and casting of the same nominal size.

THICKNESS AND WEIGHT OF PIPE.—In the classification of cast-iron pipe for different pressures and conditions is to be found a more serious divergence of opinion and practice than in any other branch of the subject. The committee has not deemed it advisable to recommend the adoption of standard weights for stated pressures for the reason that the thickness or weight of the pipe to be used depends in many cases upon other conditions in addition to the static pressure. In pipes of the smaller sizes the thickness required depends upon the strength needed to withstand handling and the strains due to the settlement of earth, and other causes, rather than upon the internal pressure. For this reason heavier pipes are required in city streets, where they are subjected to settlement from frequent excavations, than in country towns where they remain undisturbed.

Other conditions besides the pressure must also be considered in determining the thickness of the large sizes of pipe; for example, large pipes in public streets, where they may be subject to heavy loads, or in places where the depth of earth covering is great, should be made thicker than where laid in locations specially reserved for their use. The static head or pressure can be closely estimated, but the water hammer, effect of traffic over the pipe, settlement under it, tuberculation within it, electrolysis outside of it, and age everywhere, can, with present knowledge, be given no mathematical value. These conditions must, however, be taken into consideration in determining the thickness of pipe to be used in any given case.

It is probable that no formula exists which is a scientific expression of all these requirements—perhaps no such rational formula can be devised, certainly not until more definite data are secured for the various strains, both internal and external, which are sustained by pipes in use. It was finally decided to devise a table of thicknesses and weights based upon some logical formula, and to give the different weights an arbitrary classification denoted by a symbol such as a letter of the alphabet, in which the variation in weights from one class to another should not be so great that one would be unable to select pipes that would approximate his own practice and of sufficient range to cover all except the most extreme cases.

The thicknesses given in Table No. 2 were computed by the following formula, which is one used in determining the thickness of pipe used on the Metropolitan Waterworks, which supply water to Boston and other cities and towns within a radius of ten miles. Class A being for a static head of 50 ft., class B for 100 ft., etc., each class advancing by 50 ft. This formula provides factors for the deterioration of the pipe by time and other conditions, for the internal strain due to the static head and to water hammer, but, as has been previously stated, other conditions must also be considered.

$$t = \frac{p + p'}{3{,}300} r + 0.25 \text{ in which}$$

t = thickness in inches;
p = static pressure in pounds per square inch;
p′ = pressure in pounds allowed for water hammer;
r = internal radius of pipe in inches;
3,300 = ⅛ tensile strength of cast iron taken to be 16,500 lbs. per sq. in.;
0.25 = allowance for deterioration by corrosion and other causes.

VALUES GIVEN TO P′ AS FOLLOWS:

Diameter of pipe, ins.	P′ in lbs.
4, 6, 8 and 10	120
12 and 14	110
16 and 18	100
20	90
24	85
30	80
36	75
42 to 60	70

The committee does not recommend the classification of the weights upon the basis of static head, believing that to the engineer or superintendent should be left the final decision as to the thickness or weight of pipe suitable for the particular place in which it is to be used.

Table No. 2, if adopted, will furnish a basis for pipe practice in which the classes will have a uniform meaning, and when used as the basis of an order will insure to the buyer the pipe which he intends to use. This will be a distinct improvement on present conditions, under which a class letter has no meaning, except when accompanied by a statement of weight.

The table does not assume to fix the weight which shall be used for different heads or conditions of service. It is believed that the range is sufficient to provide for all usual conditions, and that the variation between one class and the next is not great enough to prevent the selection of weights that will closely approximate individual practice.

This uniform classification does not necessitate any radical departure from present foundry methods, yet it can hardly fail to be of advantage to the pipe manufacturer, especially in providing standard weights for stock pipe.

SPECIAL CASTINGS.—The general designs of the special castings recommended are of the pattern now used on the Metropolitan Water-Works. A number of foundries have the patterns for these castings, and they are already in a fair way to become a standard.

The committee is of the opinion that it would be difficult to improve upon these patterns. They are designed with the purpose of putting as little metal into the special castings (where it costs about twice as much as it does in straight pipe) as is consistent with strength and convenience in laying.

As the specifications allow a margin for excess or deficiency in weight not exceeding 6%, abnormal excess of weight (a serious fault in many castings) is avoided, and the purchaser can estimate with reasonable accuracy the cost of the castings in advance.

The outside diameter and the openings of the bell or socket are the same as those of the pipes of the same size. There is but one class of special castings for all classes of pipe below 20 ins. It is hoped that the vexing occurrence of the necessity for chipping spigots of special castings to enable them to enter the pipe bells, which has heretofore been much too common, will be avoided by this uniformity.

Tables giving full dimensions and weights will accompany the specifications in their final form.

MANUFACTURE.—The classes of the specifications which refer to the processes of the manufacture of the pipe and castings are recommended by the committee as representing in its opinion the best modern practice which has been tested by time and experience.

There are some points which are as yet unsettled, such,

*This report will be submitted to the association at its meeting at Young's Hotel, Boston, Mass., on Dec. 11. Oral and written discussions are desired. The latter may be sent to Mr. Chas. W. Sherman, Ashburton Place, Boston, Mass. The membership of the committee is as follows: Freeman C. Coffin, M. Am. Soc. C. E., 53 State St., Boston; F. F. Forbes, Superintendent Water-Works, Brookline, Mass.; Dexter Brackett, M. Am. Soc. C. E., Engineer Distribution Department, Metropolitan Water Board, Boston.

for instance, as the coating of the pipes. The committee believes that the method specified is the most satisfactory one in general use. It recognizes, however, that improvement in this mattet is to be desired. It is possible that some of the processes already suggested may prove to be better. They are yet in the experimental stage and, therefore, not suitable subjects for recommendation. Even standard specifications must be subject to revision, as experience shows their requirements to be rendered obsolete by better methods. It is, of course, always open to the purchaser to substitute requirements of his own for any clause or clauses of the specifications or in addition thereto. The fact that he may often choose to do so does not impair the value of standard specifications.

In conclusion the committee will state that the specifications are recommended to the association for criticism and amendment, if thorough discussion by all interested shows changes to be desirable.

SPECIFICATIONS.

DESCRIPTION OF PIPES.—The pipes shall be made with hub and spigot joints which shall accurately conform with the dimensions given in Table No. 1.

They shall be true circles in sections, with their inner and outer surfaces concentric.

The straight pipes shall be straight, and the curved pipes shall be true to the required curvature in the direction of their axes.

They shall be of the specified dimensions in internal diameter from end to end, and the straight pipe shall be 12 ft. in length, exclusive of socket.

Especial care shall be taken to have the sockets of the required size. The sockets and spigots will be tested by circular gages, and no pipe will be received which is defective in joint-room from any cause. The joint-room for each class of pipe shall not vary more than 0.06-in. from the dimensions given in Table No. 1.

No pipe shall be accepted when the thickness of metal in the body of the pipe is more than 0.08-in. less at any point than the standard thickness given in Table No. 2.

The length of the pipe shall not be changed except by written permission of the engineer, and in case of such change the standard weight of the pipe given in Table No. 2 shall be modified in accordance therewith.

DEFECTIVE SPIGOTS.—Defective spigot ends on pipes 20 ins. or more in diameter may be cut off in a lathe, and a half round wrought-iron band shrunk into a groove cut in the end of the pipe. Not more than 6% of the total number of accepted pipes of each size shall be cut and banded, and no pipe shall be banded which is less than 11 ft. in length, exclusive of the socket.

SPECIAL CASTINGS.—All special castings shall be made in accordance with the cuts and the dimensions given in the tables forming a part of these specifications.

The flanges on all manhole castings and manhole covers shall be faced true and smooth, and drilled to receive bolts of the sizes given in the tables. The contractor shall furnish and deliver all bolts for bolting on the manhole covers, the bolts to be of the sizes shown on plans, and made of the best quality of American refined iron, with hexagonal heads and nuts and sound, well-fitting threads.

MARKING.—Every pipe and special casting shall have distinctly cast upon it the initials of the maker's name, the year in which it was cast, and the class letter. When cast especially to order, each pipe and special casting shall also have cast upon it the number signifying the order in point of time in which it was cast, the figures denoting the year being above and the number below; thus

1901, 1901, 1901,
1 2 3

etc., also any initials, not exceeding four, which may be required by the purchaser.

The letters and figures are to be cast on the outside, not less than 2 ins. in length and ⅛-in. in relief.

PERCENTAGE TO BE PAID FOR.—No pipe shall be accepted, the weight of which shall be less than the standard weight by more than 4% for pipes 16 ins. or less in diameter, 3½% for 18, 20 and 24-in. pipes, and 3% for pipes more than 24 ins. in diameter; and no excess above the standard weight of more than the given percentages for the several sizes shall be paid for. The total weight to be paid for shall not exceed for each size and class of pipe the sum of the standard weights for the same number of pieces of the given size and class by more than 2%.

No special castings shall be accepted, the weight of which is more than 6% less than the standard weight, and not more than 6% in excess of the standard weight shall be paid for.

QUALITY OF IRON.—The metal shall be made without any admixture of cinder iron or other inferior metal, and shall be remelted in a cupola or air furnace. It shall be of such character as to make a pipe strong, tough, and of even grain, and soft enough to satisfactorily admit of drilling and cutting.

Specimen bars of the metal used, each being 26 ins. long by 2 ins. wide and 1 in. thick, shall be made without charge as often as the engineer may direct. The bars, when placed flatwise upon supports 24 ins. apart and loaded in the center, shall support a load of 2,000 lbs., and show a deflection of not less than 0.35 of an inch before breaking. Should the dimensions of the bars differ from those above given, a proper allowance therefor shall be made in the results of the tests.

HOW CAST.—The straight pipes shall be cast in dry sand molds, in a vertical position, with the hub end down, and the special castings in loam, except when otherwise permitted in writing, in either case, by the engineer.

The pipe shall not be stripped or taken from the pit while showing color of heat, but shall be left in the flasks for a sufficient length of time to prevent unequal contraction by subsequent exposure.

QUALITY OF CASTINGS.—The pipes and castings shall be smooth, free from scales, lumps, blisters, sand holes, and defects of every nature. No plugging or filling will be allowed.

CLEANING AND INSPECTION.—All pipes and special castings shall be thoroughly cleaned and subjected to a careful hammer inspection. No casting shall be coated unless entirely clean and free from rust, and approved in these respects by the engineer immediately before being dipped. The contractor shall provide a covered tramway from the casting-room to the dipping vat, so that no casting shall be liable to become wet previous to its being coated.

COATING.—Every pipe and special casting shall be coated inside and out with coal-tar pitch varnish. The varnish shall be made from coal tar. To this material sufficient oil shall be added to make a smooth coating, tough and tenacious when cold, and not brittle, nor with any tendency to scale off.

Each casting shall be heated to a temperature of 300° F. immediately before it is dipped, and shall possess not less than this temperature at the time it is put in the vat. The ovens in which the pipes are heated shall be so arranged that all portions of the pipe shall be heated to an even temperature. Each casting shall remain in the bath at least five minutes.

The varnish shall be heated to a temperature of 300° F. (or less, if the engineer shall so order) and shall be maintained at this temperature during the time the casting is immersed.

Fresh pitch and oil shall be added when necessary to keep the mixture at the proper consistency, and the vat shall be emptied of its contents and refilled with fresh pitch when deemed necessary by the engineer. After being coated, the pipe shall be carefully [illegible] of the surplus varnish. Any pipe or special cas[illegible] that is to be recoated shall first be thoroughly scrape[illegible] cleaned.

HYDROSTATIC TEST.—When the co[illegible] has become hard, the straight pipes shall be subject[illegible] to proof by hydrostatic pressure, and if required by t[illegible]neer, they shall also be subjected to a hammer [illegible] under this pressure.

The pressures to which the different [illegible] and classes of pipes shall be subjected are as follow[illegible]

Class.	Lbs. per sq. in.	Class.	Lbs. per sq. in.
A	150	D	[illegible]
B	200	E	300
C	250	F	400

They shall also be subjected to the same [illegible] by water pressure and hammer test after their deli[illegible] and before their final acceptance, if required by the [illegible]er.

WEIGHING.—The pipes and special [illegible] shall be weighed for payment under the supervi[illegible] the engineer, after the application of the coal-ta[illegible] varnish, and the weight of each pipe and special [illegible] shall be conspicuously painted in white on the i[illegible] after the coating has become hard. If desired by t[illegible]ngineer, the pipes and special castings shall be weighed [illegible] their delivery, and the weights so ascertained s[illegible] be used in the final settlement.

CONTRACTOR TO FURNISH MEN AND [illegible]ATERIALS.—The contractor shall provide all tools, [illegible]erials, and men necessary for the proper testing, i[illegible]nection, and weighing at the foundry of the pipes and s[illegible] castings, and if required by the engineer, he shall f[illegible]h a sworn statement that all of the tests have been [illegible]e as specified, this statement to contain the results of the transverse tests upon the test bars.

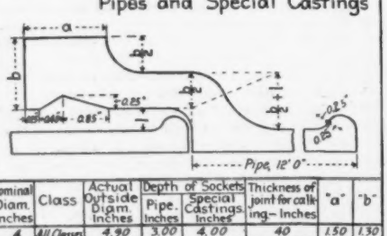
POWER OF THE ENGINEER TO INSPECT.—The engineer shall be at liberty at all times to inspect the material at the foundry, and the molding, casting, and coating of the pipes and special castings. The forms, sizes, uniformity, and conditions of all pipes and other castings herein referred to shall be subject to his inspection and approval, and he may reject, without proving, any pipe or other casting which in his opinion is not in conformity with the specifications or drawings furnished. He shall have the power to prevent the use of any metal, mold, or core which in his opinion may not be proper for the purpose for which it is intended.

CASTINGS TO BE DELIVERED SOUND AND PERFECT.—All the pipes and other castings must be delivered in all respects sound and [illegible]ormable to the contract. The inspection shall not relieve the contractor of any of his obligations in this respect, and any defective pipe or other castings which may have passed the engineer at the works or elsewhere shall be at all times liable to rejection when discovered, until the final completion and adjustment of the contract. Care shall be taken in handling the pipes not to injure the coating, and no pipes or other material of any kind shall be placed in the pipes during transportation or at any time after they receive the coating.

DEFINITION OF THE WORD "ENGINEER."—Wherever the word "engineer" is used herein it shall be understood to refer to the engineer, or inspector, acting for the purchaser, and to his properly authorized agents, limited by the particular duties entrusted to them.

Table No. 1.

General Dimensions of Pipes and Special Castings


a
b
.025
.025
.025

dams too much stress cannot be laid on the importance of making sufficient provision for the passage of flood waters during the construction of the embankment, nor to the even greater necessity for designing the overflow weirs and by-wash of ample capacity to carry off in safety the maximum floods, such as take place, perhaps, only once during a period of from twenty to forty years, and which even in a dry country may exceed by more than 2,500 times the minimum flow of the streams on which they occur.

Mr. Brooksley, as will be seen from the opening paragraph of the extract, does not agree with Mr. Mansergh's limit of 100 ft. for earth embankments, but he does agree with his predecessor in preferring puddle, rather than masonry core walls. Mr. Mansergh, however, did say that possibly he might try a masonry core wall for an all earth dam, some day (look below).

Mr. Mansergh's remarks on composite dams, like the New Croton, are reprinted here, for the convenience of our readers:

I cannot say that I much admire the American practice of building a composite dam—i. e., part of its length in earth and part in stone—as they are now doing at the New Croton reservoir of New York (which I saw four years ago), and have previously done in many smaller works. They seem to trust in Providence or good luck over there to an extent we dare not do here. In such cases the core or water-tight barrier in the earth bank is not puddle, as we should make it, but a thin stone wall joined on to the end of the true stone dam. I am not sure that such a core may not be made from end to end of an earth dam, if very special precautions are taken by well rolling the bank to ensure that unequal settlement or surging does not take place. I have never yet ventured to try it, but if I do not get nervous as I grow older I may some day.

BOOK REVIEWS.

PRACTICAL ELECTRIC RAILWAY HAND BOOK.—By Albert B. Herrick, Consulting Electric Railway Engineer, New York: Street Railway Publishing Co. Leather, with flap; 4½ × 7 ins.; pp. 398; illustrated. $3.00.

The data here gathered together relate to the construction, testing and operating of electric railway systems, according to the best American practice. Commencing with a series of tables useful in this connection, the writer takes up in detail the testing of lines, the location, construction and equipment of the track, the power station, transmission line, car-house, repair shop, etc. Under the head of operation, he gives methods of laying and schedules, data on speeds, signal and safety systems, testing and training of motormen, cost of power, repairs, etc. In the form of appendices we have chapters upon storage batteries and means of increasing power, and upon underground conduits and the third-rail system. The text avoids mathematics as much as possible, and illustrates by cuts and diagrams the appliances and methods proposed. A large amount of useful information is here compressed into a small space.

LINEAR DRAWING AND LETTERING FOR BEGINNERS.—By J. C. L. Fish, Assoc. M. Am. Soc. C. E., Assoc. Prof. C. E., Leland Stamford Junior University. Text, cloth; 10½ × 7 ins.; pp. 65; illustrated; $1. Blank Lettering Book, paper; 10½ × 7 ins.; 30 sheets ruled on one side for lettering; 25 cts. Published by the Author: Palo Alto, Cal.

The two volumes described above are designed to be used in conjunction. The text, according to the author's preface, "constitutes the course of 50 working hours in linear drawing and lettering in Stamford University as it has been given during the past eight years as preparation for the drafting in the courses in descriptive geometry, elementary machine drawing, surveying and graphic statics." As is to be expected, the work is elementary, and it is, furthermore, largely a compilation of information and methods which have been published in other books, and for much of which, we regret to note, no credit is given to the original source. The system of lettering for working drawings, which is chiefly described and explained, is that long used in the drafting room of this journal and fully described in Reinhardt's "Lettering," published in 1895.

TECHNICAL GAS ANALYSIS.—By Frank H. Bates. Leather; 4¼ × 6½ ins.; pp. 96; 24 illustrations; 3 tables. Philadelphia Book Co., Philadelphia, Pa. $1.00.

This little volume is a reprint of a series of articles which appeared a few years ago in the "Journal of Electricity." Other articles on the general subject of industrial gas, published in connection with these, will probably be similarly collected in book form in the near future. The present volume is a direct and clear exposition of several methods of procedure that may be followed in analyzing gases, such as flue gases, fuel or lighting gases, blast furnace and oven gases, etc. The apparatus used is thoroughly described and discussed. A form of apparatus that can be easily made up for one's own use is shown and its use explained; the Orsat, Elliott and Hempel forms of apparatus are then fully dealt with and a few words of discussion added to indicate the field of use and the scope of each device. A chapter on the measurement of gases, bringing out in brief form the application of the laws of Boyle and Charles, and one on the properties of gases, giving the chief data relating to the component gases (carbon dioxide, carbon monoxide, nitrogen, oxygen, ethylene, methane, hydrogen) that are dealt with in the book, follow; they serve admirably to keep before the mind the peculiarities of behavior of the gases concerned and may help to avoid many mistakes. A few tables on vapor tension of water and mercury, etc., are appended. The illustrations are rather poor, but the book as a whole is in neat, compact form. It should prove a very handy addition to the library of most engineers, particularly mechanical engineers, and those whose work is connected with the operation of furnaces, ovens or gas plants.

THE BUILDING AND ENGINEERING TRADES DIRECTORY OF THE CITY OF NEW YORK, 1901-1902, Containing complete lists of the Architects, Engineers, Builders, Contractors and all other professions and trades identified with the construction interests, together with the manufacturers and dealers in all kinds of materials, apparatus and supplies used in the construction, furnishing and equipment of buildings and engineering projects. Supplemented by an alphabetically arranged index of all the names appearing under the trade classifications. The F. W. Dodge Co., 289 Fourth Ave., New York. Cloth, 6¾ × 10 ins.; pp. 461. $5.00.

The title of the last edition of this useful work of reference leaves little to be described as to its purpose and contents. It is excellently arranged under trades and occupations, and also under names; is well printed on heavy paper, and in all ways fulfils the promise of its makers as expressed on the title page.

LE CHEMIN DE FER METROPOLITAIN DE PARIS.—Description du reseau projete, lignes actuellement executees, usine de Bercy, exploitation des lignes en service, lignes actuellement en construction. Par A. Dumas, Ingenieur des arts et manufactures, Paris, Le Genie Civil, 6 Rue de la Chaussee D'Antin, 1901. Flexible cloth; 6 × 9½ ins.; pp. 183; 105 figures in the text and 7 folding plates at end. $2.25.

This work is a methodical and complete exhibit of the proposed and executed lines of the Metropolitan underground railway of Paris, operated by electricity. The history of this project begins in 1856 and eight or more separate plans were submitted before any one was adopted for actual construction. The final plan of 1896 called for an underground system with light trains drawn by electric motors; and the City of Paris was to build the road and to lease its operation to an individual operating company. This plan has been carried out in part only; though work is in progress on other branches. The total estimated cost is about $60,000,000 for a system of lines about 48 miles long. The general conditions of construction were: That the tunnel was to follow as closely as possible the level of the surface; that curves must not be less than 100 m. radius, though in several cases controlling conditions compelled the use of curves as sharp as 75 m. and 50 m.; that all reverse curves were to be separated by at least 50 m. of straight line, except in several special cases; the maximum grade was to be 1 in 100, and where an up and a down grade would meet a level of at least 50 m. was to be interposed; there were to be no level crossings; stations were always to be located on a level grade; and, in the outer parts of the city, the line might be carried in an open cut or on a viaduct; seven-tenths, however, of the contemplated system are underground. The author minutely describes the lines actually constructed and illustrates his text with plans, views during construction and as completed. This part relates to the line from Vincennes to Porte Maillot, and two short branch lines, to Porte Dauphine and to the Trocadero. Another chapter treats of the method of execution and the cost of these parts of the system. In a total distance of 8.65 miles of double-track tunnel, the total volume of excavation was about 1,133,300 cu. yds.; and that of the masonry was 413,300 cu. yds.; about 3,600 metric tons of cast-iron and steel were used. The total cost of construction was $5,271,000, or about $609,300 per mile; but to this must be added the cost of preparatory work, tests and expense of inspection and the inspecting force, making a grand total of $7,988,200 for the work complete, or about $161 per lin. ft. The system of signals, the track and the rolling stock are described, and a full chapter is devoted to the power station at Barcy, and its equipment. In treating of the general construction it is noted that the gage of the road is 1.5 m., or 4 ft. 11⅛ ins. from center to center of rail.

Between July 19, 1900—when the road was opened—and May 31, 1901, the Vincennes-Porte Maillot line, 7.22 miles long, carried 37,949,513 passengers; the trains made 1,805,328 train-kilometers, and the receipts were $1,151,625. Including the traffic on the two short branches—which led, however, to the exposition grounds of 1900—the total traffic was 40,396,500 passengers, and the total receipts amounted to $1,228,201. The ticket tariff is as follows: 5 cts. first class; 3 cts. second class; 4 cts. for return tickets in the second class good only before 9 a. m.; and 1 ct. for city school children in the charge of a teacher. The operating company pays to the City of Paris 2 cts. on each first-class ticket sold, and 1 ct. on each second class and return ticket sold. For the period named the total profits of operating this line were $638,813, of which the City of Paris received $361,293. These figures show that the municipality receives nearly 60% of the profits of operation; the figures given also show that the operating expenses range from 40 to 44% of the gross income. The remainder of the volume is devoted to a description of the stations, the ticket system and the lines now under construction.

THE AMERICAN INSTITUTE OF MINING ENGINEERS IN MEXICO.

(Continued from p. 406.)

PACHUCA, Saturday, Nov. 16.

The next day the party divided into two parts, the majority went in carriages six miles into the country to visit the mines of Real del Monte, and after a trip through various shafts, tunnels, etc., underground, an "almuerzo campestre," or outdoor breakfast, was partaken of. This was served in a new wooden building erected for the occasion, handsomely decorated with red, white and green paper (the Mexican colors). The trip occupied all day, and those who took it reported that it was one of the most enjoyable affairs thus far experienced.

The other party stayed in town and visited several silver reduction works. The first was the Guadalupe patio works, already described, in order to get a better view of it than was obtained the day before. Several of the patios, each about half an acre in extent, were being stirred up by droves of 25 or 30 mules, and others were being turned over by bare-legged men with shovels. The process of treating the tailings of the patios, by the German buddle method, was observed. The product of this operation is a concentrate, containing silver which has not been amalgamated, which is sold to smelting works.

The next place visited was the Hacienda de la Union, where the Kroenke process of reduction is in operation. The ore is crushed and then pulverized in Chilian mills, and the mud so made is spread out on a large stone pavement to dry. When dry it is put into a rotating barrel with a concentrated solution of salt, subchloride of copper and quicksilver, and rotated for eight hours, when the amalgamation is completed. The difficulty with this process seems to be that of drying the mud in the open air.

The third works on the program was the Hacienda de la Progreso, or No. 2 works of the Compania San Francisco. In this works the ore, after being crushed, is pulverized by stamps, and the pulp is run into a mixing tank, when it is dosed with salt, sulphate of copper and quicksilver and run through a series of amalgamating pans, the process being known as the "Boss" system from the name of its inventor. It is said that this process is better adapted for the handling of low-grade ores than either the patio or the Kroenke process, but it allows more silver to run to waste in the tailings. There is an excellent compound condensing engine, of German make, with Sulzer valves, in these works, but it was being run non-condensing, on account, so it was said, of the expense of obtaining condensing water. All of these three works have one modern feature, the use of electric motors, driven by current generated by a waterfall 10 miles from Pachuca.

The fourth and last plant visited was a concentrating works just erected by a Mr. Bronson, from the United States, on the stream which receives the final tailings from all the works in Pachuca. He pumps the whole stream through his plant, and floats it onto a series of inclined canvas tables. Each table receives a supply of muddy water for about ten minutes, depositing on it the heavier particles that are carried in suspension, and it is then washed. Mr. Bronson says he expects to recover $300 worth of silver per day that is thrown away by the other mills. Besides the concentrates caught on the canvas slime tables, he also catches some mercury and silver amalgam in riffles in the sluices leading to the tables.

The chief impression gained by our party after an inspection of the mines and reduction works that we have seen, is that Mexico before long, when modern methods of operating are introduced, with American capital, will enormously increase its output of silver. Whether the present price of silver can be maintained when this increase of production takes place coincident probably with an increased production of gold is a matter of world-wide importance.

GUADALAJARA, Monday, Nov. 18.

On Saturday evening we left Pachuca and arrived here at 11 a. m. Sunday, two hours behind our schedule time. On arrival we were met at the station by a large committee of the Engineers' Society of the State of Jalisco, and listened to a speech of welcome, which was replied to by President Olcott. We were then given a printed program, which left us free to our own devices on Sunday, and gave us all we could ask for in the way of entertainment the following day. The splendid cathedral, a few blocks from the station, was visited by the party; also the market, which was in full operation. Here is the program, which was faithfully carried out on Monday:

Monday.

9 a. m.—The delegation in charge of the committee of the "Sociedad de Ingenieros de Jalisco" will leave the Mexican Central Ry. depot, for a car ride along the Hospicio Ave.

9.30 a. m.—Arrival at the Hospicio (the City Orphans' Asylum) and visit of inspection to same.

10.30 a. m.—The delegation and committee will drive back to the Plaza de Armas.

10.45 a. m.—Visit to the Cathedral, Plaza de Armas, Government Palace and other points of interest.

11.30 a. m.—Private street cars will take the distinguished guests and the Entertainment Committee to the Barranca de Oblatos.

1 p. m.—Luncheon will be served at the Oblatos restaurant. Address by Mr. Ambrosio Ulloa, Secretary of the Sociedad de Ingenieros de Jalisco.

4 p. m.—The guests will be escorted by the committee to the Plaza de Armas, and taken for a visit of inspection to the School of Arts "Espiritu Santo," riding through the French Colony.

5.30 p. m.—Car ride through the American Colony and visit to the American Sanatorium.

6 p. m.—The delegation will be escorted to their private palace cars at the Mexican Central Ry. station.

7 to 9 p. m.—A special band concert will be given in honor of the distinguished ladies who accompany the delegates to this city.

10 p. m.—Farewell greetings will be extended at the depot by the General Reception Committee to the honorable ladies and members of the delegation.

The City Orphan Asylum, which was visited in the morning, is on a most remarkable plan. It covers a large square, and is divided into 23 patios or courts, which contain orange trees, palms, fountains and other embellishments. It is an asylum for the poor of all ages, and contains about 600 inmates. Schools of various kinds, including trade and manual training schools, are included in the building. The place is admirably managed, under care of the state. One of the interesting occupations of the inmates is the making of the well-known Mexican drawn work and embroidery.

The School of Arts, or industrial school, is under the care of the clergy. It is a fine, large building, not yet completed. It contains a foundry, machine shop, carpenter shop, etc., for instruction of boys. The sanitarium is an American institution, a branch of the well-known sanitarium at Battle Creek, Mich. It is a fine place, well conducted and well patronized.

The event of the day was the trip by mule car and steam car to the Barranca de Oblatos, a remarkable canyon, 1,500 ft. deep, six or eight miles from the city, and the Mexican breakfast served at the restaurant on the brink of the canyon. The meal was served in courses, and the dishes were all Mexican and therefore not all acceptable to our untrained palates. After lunch we were entertained by Mexican dances of the rancheros and music by a large band. The scenery and the curious groups seen on this trip were a constant source of excitement, and we returned to our cars more than pleased with our experience. We leave Guadalajara at 11 p. m. and begin our journey homewards.

AGUAS CALIENTES, Nov. 21, 1901.

We reached Marfil Depot, the railroad terminal three miles from Guanajuato, at 8.30 a. m. on Tuesday, Nov. 19, and there was the inevitable reception committee and the brass band. After a short speech of welcome we embarked on several three-mule cars and proceeded up the narrow gulch and through the narrow streets of the town lined dith old haciendas or reduction works and with one-story adobe and stone houses of most primitive architecture to the Guanajuato Club, which was our headquarters and resting place during our two days' stay. The clubhouse is commodious and comfortable, three stories high. The club has many American and English as well as Mexican members, and is the principal social rendezvous.

The first visit was to the reduction works of the Guanajuato Consolidated Mining and Milling Co. It was not in operation, as it is being reconstructed, and modernized, 40 stamps being added to the original 20. The ore, after being pulverized, is concentrated on Whilfley tables, and then run into amalgamating pans. From the reduction works, a half-mile walk along a railroad track, led us to the opening of the old mine, and another walk of the same distance through a splendid level tunnel, lighted by electricity, brought us to the present workings. Here we saw Mexican mining in its most ancient form. The miners were naked, except a small cloth about their loins, and the ore was hoisted from a depth of about 80 ft. by men carrying sacks on their backs and climbing up a very steep stone stairway. It is said that there is $5,000,000 worth of ore in sight, and probably vast quantities yet to be uncovered. The region around Guanajuato is wonderfully rich in gold and silver, and the coinage statistics show that it produced $643,000,000 from 1701 to 1887. The greater part of the population of the town, 41,000 in number, is employed in the mining industries. The country for miles around contains the remains of abandoned works of the ancient style, but there are many signs of new developments with modern machinery and methods, and it is probable that within a few years there will be a great revival of the mining industry.

No visitor to Mexico who is interested in mining and milling of ores should fail to visit Guanajuato. He will find here more of the quaint and curious than almost anywhere else, and the town itself is one of the most remarkable we have visited. The New Juarez theatre is a splendid specimen of classic architecture, and we were fortunate in meeting its architect, Mr. Alberto Malo, who spent several years in the United States.

About four miles from the city is the Esperanza reservoir, with one of the finest large dams in the world, 33 metres in height. Nearer the city is a circular stone reservoir with a sand filter bed, 30 meters in diameter.

On our reteurn from the mine we had lunch at the State College, a fine building, four stories high, and as the lunch was entirely of American dishes it was a pleasant surprise after the Mexican "breakfasts" we have had. The college contains a mineralogical and geological collection which was visited by those interested. After the lunch we were taken in mule cars to the La Presa Park, a beautiful place, and a few of us had the opportunity of making a visit to the elegant residence of Mr. Furness, the American Minister, who was one of the leaders of the reception committee.

After dark the Juarez theatre, which has not yet been opened officially, as it is waiting for a formal visit by President Diaz, was opened and illuminated in our honor, and the military band occupied the stage and played several selections. We then returned to the club, where a ball was given. The governor of the State of Guanajuato and his wife were present, with many Mexicans and their ladies. At 11 p. m. we were taken back to Marfil by the mule-cars.

The next day the great event for the men of the party was an excursion on saddle horses loaned for the purpose by the cavalry detachment located in the city to the Esperanza reservoir and to several mines, some of which were working and others abandoned. One of the mines had an octagonal shaft about 32 ft. diameter and 1,600 ft. deep, lined throughout with stone. It was made so large because the hoisting was done in buckets by means of whims worked by horses, and there were several buckets hoisted at a time. The mine is now idle, and the shaft is half full of water. The ride will never be forgotten by those who participated in it. Much of the road seemed more suitable for goats than for horses. There were water-worn gullies of stone, at an angle of 30° to 45°, about 200 ft. in height, to be traversed, but not a horse stumbled, nor did any accident take place. On our return we had lunch again at the State College, and a couple of hours in the afternoon were spent in visiting the historical Granaditas building, and the Flores reduction works, where both the arrastra and the patio processes were seen in operation. There are 40 arrastras in the works and the whole place was of the most antique pattern. At 4 o'clock we returned to Marfil, and at 5 our train left for Aguas Calientes, where we arrived early in the morning.

Aguas Calientes is noted for three things—the warm water baths, which we all patronized, the drawn work which women brought to the train, and of which our party must have bought some thousands of dollars worth, and the large reduction works, formerly the Guggenheim works, now belonging to the American Smelting and Refining Co.

There was a reception committee in frock coats and silk hats, and a band of music, of course, but to our gratification they did not appear until 9 o'clock, after we had eaten a comfortable breakfast. The committee took us in mule cars to the Governor's palace, where we were received by the Governor, and then to the smelting works. This works is thoroughly modern, containing both lead and copper furnaces, and converters for the Bessemerizing of copper matte. The product is base bullion and copper bars, both of which are shipped to Perth Amboy, N. J., for refining and extraction of the gold and silver. It is said that $3,000,000 is to be expended in new construction in these works, making these one of the largest smelting works in the world. After our visit to the works we were treated to luncheon in the hotel belonging to the company. The afternoon was spent in bathing, in resting, in bargaining for drawn work, and in listening to music in one of the parks. More music is to be given from 8 to 11, and we leave at midnight for San Luis Potosi.

ON TRAIN, NEAR MONTEREY, Monday, Nov. 25.

On Friday morning we were welcomed at San Luis Potosi by a military band, and the local committee escorted us to street cars which took us to the Government Palace, where we shook hands with Senor Ingeniero Don Blas Escontria, Governor of the State of San Luis Potosi, and a distinguished engineer. He made us a speech in Spanish which Mr. Olcott translated for our benefit and then replied to it in Spanish. We were then taken back to the station, and thence by train to the smelting works of the Compania Metallurgica Mexicana. This is a splendid works, thoroughly modern, turning out silver lead bullion and copper matte, which are shipped to the United States for refining. It is owned by Americans, and is in charge of an American engineer, Mr. A. S. Dwight, who acted as chairman of the local committee. Besides the sampling works, the smelting and roasting furnaces and the machinery, there is in the works a plant for making tannin extract out of the bark of the wood which is used for fuel. The bark is ground and then leached in large vats, and the weak solution thus obtained is concentrated by boiling in a vacuum pan. The extract is exported for use in tanneries.

The social features of our visit to the metallurgical works surpassed anything of the kind that we have yet experienced. Mr. Dwight has a commodious residence close by the works, with a large porch on the second story, looking out on a magnificent view with high mountains in the far distance, and in front of the house was a large and beautiful garden, in which were set tables shaded with awnings and decorated with flowers. All of this was at our disposal for a resting place during our visit, and at 1 o'clock an excellent lunch in the American style was served by an efficient corps of waiters.

At 2.30 p. m. the train carried us back to the town and the party broke up into groups to visit different places of interest. Several of us vitised the furniture factory of Jorge Unna & Co., and the tobacco factory of Senor D. Antonio Delgado Renteria. The furniture factory is a remarkable place. Mr. Unna is a German who began the business with six workmen only twelve years ago, but the works now occupies a whole square and employs 200 people. Furniture of the highest quality only is made, and it is all hand made and hand carved. The works includes an iron foundry and machine shop, [illegible] shop, including sawing and planing machines, [illegible] grinding, polishing and silvering shop, weaving ma[illegible] for weaving braids, a designing and drafting ro[illegible] and storehouses where are kept in the most perfec[illegible] the thousands of things that are necessary to the p[illegible]ion of the great variety of artistic furniture turned o[illegible] the establishment. The designs are made after a [illegible] of albums of engravings and photographs of the best [illegible]pean furniture, both old and new. There is nothi[illegible] the works to remind one of an American factory whe[illegible]ntity and speed of production are the great essentia[illegible]s all essentially German and Mexican.

The tobacco factory makes cigars by ha[illegible]d cigarettes both by hand and by machinery. A [illegible] American cigarette machines are in use, but the sty[illegible] cigarette preferred by the Mexicans is made by hand [illegible] machinery has not been adapted for making it. In one [illegible] we saw over 400 girls, sitting in rows, each with a [illegible] wooden bowl containing the tobacco. The task of [illegible] was the rolling of 3,200 cigarettes, which was acc[illegible]ished in 7 or 8 hours, the wages paid being 60 or 7[illegible] cts. Mexican, per day. The clean and respectable [illegible]rances of these Mexican girls was most noticeable.

In the evening there was a serenade by the [illegible]rds of the 15th Infantry and of the Military Industri[illegible] School. It was held in the Plaza des Armas, a small [illegible] in front of the Palace. Seats were provided for our pa[illegible], and the whole population of the city seemed to be pres[illegible] walking around the park in two double rows, one [illegible] men, the other of women, or standing in crowds th[illegible]ughout the park and in the surrounding streets. It was especially noticed that the majority of the people wore American dress in all its varieties, only a minority wearing the Mexican sombrero and zerape. Shoes were also worn by nearly all, bare feet and sandals both being much more rare than we have seen in other places.

At 10 o'clock a grand ball was given in the clubhouse of the Sociedad Potosina. The ballroom is one of the finest rooms we have seen in our travels. It is said to be a copy of the ballroom in the Winter Palace in St. Petersburg. The decorations and the general color effect are exquisite. During the ball a supper was served in the French style, in 13 courses, with French wines. After the ball the special street cars returned us to the train, and we left for Tampico, at 2 a. m.

All day Saturday was spent on the train. The memorable events were the descent of the mountains in serpentine curves, winding through gorges and alongside of precipices, and the derailment of one of the trucks of the special car on our second section twice within a few miles, while going around 22° curves. These accidents delayed us two hours.

We stopped for an hour at Cafetal, to visit the wonderful grotto and waterfall, which was reached by climbing down 475 steps made of railroad ties. The grotto is a pool about 100 ft. diameter surrounded by vertical walls 50 or more feet in height, which are surmounted by dense tropical vegetation. There is one large stream which tumbles through a steep gorge into the pool and dozens of smaller streams trickle over the top of the wall. The water escapes from the pool through a natural tunnel in the rocks to the river below. The whole forms a scene of surpassing beauty which our oldest travelers say they have never seen equalled. Another fine piece of scenery, to view which we stopped 10 minutes, was La Abra Falls, a succession of falls aggregating about 200 ft. Choy Cave, a great limestone cave, hung with stalactites, was also visited by our first section; but the second section failed to see it on account of darkness. The two sections reached Tampico respectively at 7 and 9 p. m., but as it is not a pleasant place to stay over night, we were taken six miles further to La Barra, on the Gulf of Mexico, where there is a magnificent beach. The moonlight made the sand look like snow, and a strong sea breeze blowing directly off the Gulf was most invigorating after our long day of travel.

On Sunday we stayed on the beach till 3 p. m. Religious services were held in the pavilion, after which we divided into two parties, male and female, and bathed in the water of the Gulf at two points half a mile apart. The favorite bathing dress was pajamas. The water was at a temperature of about 80°, or about that of the air in the shade, and the beach was equal to Cape May at its best, with a fine surf rolling in.

We left La Barra at 3 p. m. and then had a fine example of Mexican railway management. We were told that we would have over an hour to stop at Tampico, to see the town, and that we would leave there at 5 p. m. sharp, the hour being needed by the commissary department to obtain ice and other needful articles. It took us till 4.45 to get to Tampico, 6 miles, and then we were told by the railroad officials not to leave the train as we must leave at 5. At 5.20 we began to move, then stopped, moved a short distance, stopped again, waited for another locomotive to haul us, and finally got away from the town at 7.05.

The night's ride will never be forgotten by our party. Of all the tracks over which Pullman cars ever run, the Monterey & Mexican Gulf must be the worst. Such swinging and rolling and creaking of cars we have never before experienced. We were due in Monterey at 8 a. m., but it is now 12.30 p. m., and we are still 36 miles from

it, and running at about 20 miles per hour, not including stops which are very frequent. We have two old wood-burning locomotives, and they have to stop for wood every ... miles. The weather is hot and the scenery monotonous and uninteresting. If ever we come to Mexico again we will try to avoid this trip from Tampico to Monterey.

W. K.

P.S.—We have just learned that yesterday the railway changed owners, passing into the control of the Mexican Central Railway Co. It is to be hoped that it will soon abolish the sharp curves on the road descending the mountains east of San Louis Potosi, improve the surface and straighten out the track between Tampico and Monterey, adopt coal-burning locomotives, and inject into the traffic department some of the energy and dispatch which we so much admired on our trip over its main line between El Paso and Mexico City.

A CARPENTER'S SUSPENSION BRIDGE AT SHAWINIGAN FALLS, PROVINCE OF QUEBEC.

The description of a primitive Kentucky suspension bridge, published in our issue of Oct. 10, has called forth an account of another structure of similar type lately erected by a local carpenter at Shawinigan Falls, Province of Quebec.

In this case, the main span is 95 ft., with approaches 35 ft. and 40 ft. long, respectively. The cables are old 1-in. derrick guys, spaced 5 ft. apart. At intervals of 4 ft. wooden cross pieces, 2 × 6-in. × 6 ft. long, are fastened with hook-bolts.

SUSPENSION FOOT-BRIDGE OVER SHAWINIGAN RIVER, SHAWINIGAN FALLS, P. Q.

A 2-in. plank floor is laid on the cross pieces, and the wooden railing with 2 × 4-in. top piece on each side acts as a fairly efficient stiffening truss. Braced posts are used for piers, and the cables are anchored to "deadmen" sunk at either end. As originally built the middle span had a sag of 3 ft. below the horizontal drawn from tops of piers; but by the stretching of the cables this sag is now 5.2 ft.

Mr. George P. Hawley, Assoc. M. Am. Soc. C. E., who sends us this item, says the bridge is quite rigid and is much used. The Shawinigan River, at this point, has a range of 25 to 30 ft.

THE EFFICIENT WORKING OF GAS PLANTS FOR GAS ENGINES.*

By Joseph Emerson Dowson,† M. Inst. C. E.

In general, the gas plant is to the gas engine what the boiler is to the steam engine, and it is at least as important to consider the efficiency of the gas plant as that of the boiler. It may even be more important to consider the former than the latter, since the gas produced is almost of necessity subject to greater variation in the qualities which give it driving power than is the case with steam. The object of the gas plant is to transform solid fuel into gas suitable for working an engine, but it must not be supposed that this transformation can be effected without the loss of some of the heat energy in the solid fuel; it is necessary to pay toll on the way, in the process of making the gas. To determine the heat efficiency of the plant, account must be taken of all the fuel consumed in the apparatus used for making the gas, and the percentage of the total heat energy of the fuel consumed which is available in the gas finally passed into the holder should be calculated.

The author considers it important that all experimenters should adopt one and the same basis of comparison, and he submits that the only true basis is a balance sheet of the heat units, such as is now usually adopted in considering the heat efficiency of a gas or steam engine.

*From Minutes of Proceedings of the Institution of Civil Engineers.

†39 Old Queen St., Westminster, London.

From the practical point of view, the plant should be compact and easy to work, it should produce gas as quickly as it can be consumed, its first cost should not be excessive, and it should not involve a serious charge for repairs. Apart from these considerations, it is all-important that the gas produced should be suitable in quality, not merely for an hour, but for several hours consecutively, and for this the best working conditions for each type of plant must be known, and it must be ascertained how far they can be maintained. Further than this it must be known what kind of fuel can be used in each plant, so as to yield a gas sufficiently strong and sufficiently clean for engine work. In producers used for furnace work, i. e., where the gas is taken direct from the producer to the combustion chamber of the furnace, the gas is usually made with bituminous or semi-bituminous coal, and the tarry vapors distilled off in the producer mix with the gas and enrich it, and all are burnt in the furnace. For engine work it is essential not to have condensable tarry vapors with the gas; otherwise the valves will be clogged and other troubles will ensue. For this reason nearly all the producer gas now used for engine work is made from anthracite or coke; there is a notable exception which will be dealt with later. It is unfortunate that these heat-giving hydrocarbon vapors cannot be used in engines, as gas mixed with them usually has a higher calorific power than gas made from anthracite or coke. If, however, the object be to consider what kind of producer gas is suitable for engine work, or to compare the gas made in different engine plants, it is necessary to consider not only its heating or explosive power, but also its freedom from tar and other impurities.

Another important point to be considered is how far the maximum production of a producer can be reduced, without injuriously affecting the quality of the gas. This is too often lost sight of.

To work a generator of moderate size with coke, at half power continuously, would necessarily be attended with certain drawbacks. The fire in each generator would be at a lower temperature, while the radiating surfaces of two generators would be double those of one.

The fact of working two or more generators together does not in the least affect the quality of the gas, provided the plant is suitably arranged, and the author has designed many plans which are working satisfactorily with two or more generators. At the cocoa factory of Messrs. Van Houten & Sons, near Amsterdam, there are eight generators all working together and feeding one gasholder through one connecting main. At Messrs. Crossley's works there are two generators of about 300 HP. each, which have worked together for years, and the calorific power of the gas made varies very little, the average in a day's run being as high as 1,552 calories per cubic meter at standard temperature and pressure.* There is, in fact, no more difficulty in working two or more generators together than in working a bench of coal gas retorts.

With an anthracite fire in the generator, the maximum production of gas in small generators can be reduced 30%, and in large generators it can be reduced 30% to 50% without altering appreciably the quality of the gas; but experience has shown that with a coke fire, which is less dense than anthracite, it is not well to reduce the maximum production by more than one-third. The depth of the fire depends a good deal on the size of the generator and on the nature and size of the fuel. Formerly the author used, almost exclusively, anthracite nuts or cobbles, in pieces about 1½ ins. to 3 ins. cube, and with this the fire was 3 ft. to 6 ft. in depth, according to the size of the generator. More recently he has used anthracite peas, which pass through ¾-in. and over ⅝-in. or $^5/_{16}$-in. screens, and these are usually 5s. to 6s. a ton cheaper than nuts. With peas the fire is 2 ft. 6 ins. to 4 ft. deep, according to the size of the generator. When coke is used, the author prefers to have it in pieces about ¾-in. cube, and the depth of the fire should be 3 ft. to 6 ft. or 7 ft., according to the size of the generator.

When anthracite or coke is used, the removal of clinker is troublesome in all generators, especially if a high steam pressure is used. When the plant is worked in the day time only, the author's practice is to rake the fire and remove the clinker once a day, usually the first thing in the morning, before gas is made. When it is necessary to keep the plant working continuously night and day, as in a flour mill for instance, the fire is raked through suitable stoking holes in the doors of the generator, and the clinker is drawn out once a week. In some other types of plant the clinker is allowed to accumulate for 24 hours or 36 hours, when the working of the generator is stopped for 3 hours or more to remove the clinker and make up the fire.

In a few plants, various modifications of rotary grates are used, but they are not entirely satisfactory. They discharge the clinker which is on the grate itself, but they do not thoroughly remove the clinker which adheres to the brick lining of the generator; they also cause a good deal of small anthracite to fall down with the ash and clinker into the bottom of the generator. Another type of rotary grate will be referred to later. When bituminous coal of fair quality is used there is not so much clinker as with anthracite, and various kinds of grate will serve; but at present a large Mond plant is the single good instance of a plant yielding gas clean enough for engine work when bituminous coal is used. With the smaller Mond plants, the tar difficulty has not yet been got over.

In small generators it is desirable that fuel should be put into the generator in small quantities and at tolerably frequent intervals; but in large ones it is sufficient to put in fuel every 30 minutes or 45 minutes when the plant is working hard. Longer intervals may be allowed when the rate of production is reduced. One writer has recently stated that when fresh fuel is put in the generator it raises the quality of the gas, and has more influence on it than the depth of the fire; but it would be a mistake to accept this as a general rule. With bituminous, or semi-bituminous coal, hydrocarbons are given off soon after the new coal is put into the hot generator; but this is not the case with anthracite or coke, and the author is of opinion that with any kind of fuel it is essential to maintain the requisite depth of fire to insure not only the decomposition of the steam, but especially the reduction of the carbon dioxide.

It has naturally occurred to designers of gas plants to feed the generator with fuel automatically. Where gas is made on a large scale and where the rate of production of a generator is constant, an automatic feed can be used; but for a plant of moderate size, which serves one or more engines with varying loads, there would be an element of risk in trusting to a mechanical feed. In a generator for 100 or 200 brake HP. the body of fire is small, and if too little or too much fuel were put on, the quality of the gas would suffer; and if the load on the engines varied greatly, the mechanical feed would have to be regulated by the fireman. Practically, this means that with a plant of this size the attendant must be present, and as he is there it is better that he should put on the fuel and be responsible for it; for the outputs mentioned, the weight of fuel would not exceed 1 cwt. to 2 cwt. per hour. In some places it is a convenience to have a large hopper over the top of the generator, so that coal may be let in at intervals.

Generator gas is made rapidly, and in a moderate-sized plant it usually leaves the generator at a temperature of about 500° C. Special attention must therefore be given to the cooling of the gas, so that when it leaves the gas holder its temperature should not be higher than that of the surrounding air. In a plant serving over 500 brake HP., as at Messrs. Crossley's works for instance, gas is consumed at the rate of something like 42,000 cu. ft. per hour, and it will be readily understood that to bring this down from 500° C. to 15° C., or thereabouts, without an excessively large or costly plant, is not easy. It is, however, desirable for the good working of the engine that the charge of gas admitted to the cylinder should be cool, so that a given volume may contain as much energy as possible.

As to the calorific power of the gas, it should be considered bad for engine work unless it gives at least 1,200 calories per cubic meter = 135 B. T. U. per cu. ft. at standard temperature and pressure. It should also contain not less than 15% of hydrogen to insure fairly prompt ignition in the cylinder. Carbon monoxide is comparatively slow to ignite, especially when surrounded by a large body of nitrogen and other inert gases; it therefore needs the presence of hydrogen, and it is for this reason that the author has always endeavored to get as high a percentage of this gas as possible. In the gas made in the Dowson apparatus it is usually 18% to 20% by volume.

The foregoing remarks go to show that there are several practical considerations to be taken into account, and with these in view, it will now be well to consider briefly the distinguishing features of the leading types of plant used for making gas to drive engines. Broadly speaking there are three types, viz.:

A. Producer with jet of superheated steam forcing in air, e. g., the Dowson plant.

B. Producer without steam jet, and with blower to force in air, e. g., the Lencauchez and the Mond plants.

C. Producer without steam jet and without blower, the air being drawn into the producer by a suction pump attached to the gas engine, e. g., the Bénier plant.

*0° C. and 760 mm. To express calories per cu. meter in B. T. U. per cu. ft., multiply by 0.1124.

Type A.—Producer with jet of superheated steam forcing in air.—This type is used much more than any other; it is usually provided with an independent boiler with superheating tubes, and a jet of steam at a pressure of 30 lbs. to 60 lbs. per sq. in. (according to the size of the producer) is used for the double purpose of supplying the steam to be decomposed, and of carrying in an induced current of air, to maintain combustion of the fuel, and to promote a high temperature while the chemical reactions are taking place. In practice, about 90% of the steam produced in the boiler is decomposed in the generator, the remainder being lost. It should also be noted that the percentage of hydrogen in the gas is not strictly a measure of the quantity of steam decomposed, as some of the hydrogen is derived from the coal in the generator. By close attention to various details the author is able in practical work to decompose about ¾-lb. of steam for each pound of anthracite consumed in the generator, and he is able to do this without having more than 4% to 6% by volume of carbon dioxide in the resulting gas. It is sometimes remarked that there cannot be a gain in raising the percentage of hydrogen, if at the same time the carbon dioxide is proportionately increased, and this point is worth considering. Supposing a sample of gas to have the following composition by volume:

Hydrogen	15%	Carbon dioxide	4%
Carbon monoxide	27%	Nitrogen, etc.....	54%

the calorific power of this gas at standard temperature and pressure would be 1,289 calories per cubic meter. If the hydrogen were increased 5%, a gas of about the following composition by volume would probably result:

Hydrogen	20.0%	Carbon dioxide.....	6.5%
Carbon monoxide...	22.8%	Nitrogen, etc.....	50.7%

This would have a calorific power of 1,314 calories per cubic meter, and at first sight there would appear to be little gain in raising the percentage of hydrogen if there were a proportionate rise in the carbon dioxide, but a certain increase of hydrogen materially assists the prompt ignition of the charge in the cylinder of the engine, and for this reason alone it is important to secure as much hydrogen as possible without having more than 6% of carbon dioxide. Ordinary producer gas, as used for furnace work, in which there is about 24% to 27% of carbon monoxide, but only 6% to 10% of hydrogen, cannot be used for engine work because it is too weak and too sluggish to ignite promptly, even when the percentage of carbon dioxide is low.

An average of the results of all the trustworthy trials of Dowson plants of which the author knows (apart from mere trials of the fuel consumption per HP., when working with engines), show that the average calorific power of the gas was 1,432 calories per cubic meter, at standard temperature and pressure, while the average heat efficiency of the plant was 78.9%, being in one case as high as 81.1% and in another 82.7%. With an efficiency of 80%, the loss of heat may be accounted for approximately as follows:

Loss in boiler.....	7%
Steam not decomposed in generator.....	1%
Unburnt anthracite lost in ashes[1].....	2%
Sensible heat of gas lost in cooling, scrubbing, etc., and in radiation from generator.....	10%
Total	20%

Type B.—Producer without steam jet and with blower to force in air.—In the Lencauchez plant[2] there is no boiler, the gas being made by forcing the air from a blower into the gas generator, and there saturating it with moisture, before it enters the fire. When good gas has been produced, the blower is driven by the engine, but when there is no gas it is driven by hand-power. Some of these plants are working in France, and a few have been tested for fuel consumption per HP., but none appear to have been tested thoroughly as to their heat efficiency, etc. Professor Witz refers to this plant in his "Moteurs à Gaz," but seems doubtful about the heat value of the gas. Mr. Bryan Donkin also mentions it,[3] and gives the following as the composition of the gas by volume, but the analyst is not named:

Hydrogen	20.0%	Carbon monoxide...	21.0%
Oleflant gas.....	4.0%	Carbon dioxide.....	5.0%
Oxygen	0.5%	Nitrogen	49.5%
Total			100.0%

This would give a calorific power of 1,858 calories per cubic meter. The heat value of the coal from which it was made is not given, nor the yield of gas for a given weight of fuel.

The Mond plant has been fully described and illustrated in an interesting paper communicated to the Institution by Mr. H. A. Humphrey.[4] This plant was devised primarily for the recovery of ammonium sulphate, and the combustible gas obtained during the process was, so to speak, a by-product. At first all the gas was used for heating some large furnaces, but afterwards trials with a gas engine showed that it was suitable for that purpose, and several engines are now working with it at the chemical works of Messrs. Brunner, Mond & Co. A recovery plant of this kind can only be worked on a large scale, night and day, one producer making sufficient gas for 2,000 HP. It is, therefore, not a plant which can be used merely for power purposes on a moderate scale, but it has the great merit of being the only plant working with ordinary bituminous coal, which yields gas clean enough for engine work. The tar is removed by an extensive system of washing and scrubbing.

In this plant there is no boiler, but a certain amount of steam is taken from other parts of the works, and all the air required (about 1,500 cu. ft. per minute) is sent into the producer by a blower, driven by an independent engine. The heat value of the coal used in the producer was 7,225 calories per kilogram,[5] and this weight of coal when gasified was estimated to yield 4.69 cu. m. of gas at standard temperature and pressure, having a calorific value of 1,385 calories per cu. m. If this estimate is correct, the heat efficiency of this plant is 79% when calculated on the same basis as that of the other plants referred to.

It has been proposed to work a plant of this type without the recovery of ammonium sulphate, and if this were done it would be nearly on the same lines as the Lencauchez plant; but in the latter anthracite coal is used for engine work. In the Mond gas there is as much as 16% by volume of carbon dioxide, but this is partly compensated for by the hydrogen, which is as high as 29%.

Type C.—Producer without steam jet or blower.—In this plant there is no steam boiler or air blower, the air being drawn into the producer by a suction pump attached to the engine. The quantity of air drawn in varies with the volume of gas consumed, and as it is governed by the engine itself there is no storage of gas in a holder. The latter is dispensed with altogether, the gas plant consisting merely of a producer, a washer, and a scrubber. The fire grate is of special construction, and in it water is vaporized, and this water vapor mixes with the air before the latter enters the fuel column. The idea is ingenious, but the results obtained have not been encouraging. The plant is fully described by Professor Witz,[6] who made careful trials of it in December, 1894, with an engine of about 15 brake HP.

The first trial was with English anthracite of good quality, of which the heat value was assumed to be 8,000 calories per kilogram. The gas contained 0.3% of oxygen and only 0.8% of carbon dioxide, and by calorimetric bomb it gave 1,149 calories per cu. m. at standard temperature and pressure. The engine developed 27.6 I. HP., but only 14.59 brake HP., while the consumption of anthracite was 715 grams per brake HP. hour. A second trial was made with ordinary gas coke in the generator, of which the heat value was estimated at 6,800 calories per kilo. The gas contained 0.3% of oxygen and 1.53% of carbon dioxide, while its calorific power was as low as 1,035 calories per cu. m. The engine developed 14.7 brake HP. and the consumption of coke was 752 grams per brake H P. hour. These results were obtained with full load on the engine, and it is probable that the gas would have been still weaker if the load had been much reduced, as the temperature of the fuel most favorable for making gas would not have been maintained. There is the further disadvantage that if there were two or more engines in a factory, it would in most cases be inconvenient and wasteful to have a set of gas plant for each engine, and it would seldom be possible to work two or more engines from one producer without a gasholder.

The author has not included water-gas plants among those which are suitable for engine work, chiefly because the producers of such a plant must be worked intermittently, with frequent reversals, and this necessarily causes the quality of the gas to vary considerably. The weak gas which is blown off as waste also adds seriously to the fuel consumption.

In all the foregoing calculations the calorific values of the generator gas have been based on the following heat values:

	Calories per cu. m.
Hydrogen	3,070
Marsh gas, CH_4.....	9,550
Oleflant gas, C_2H_4.....	14,070
Carbon monoxide, CO	3,070

The calorific power of the fuel, where it was not tested by calorimeter, was calculated from the formula

$$80.8\ C + 345\left(H - \frac{O}{8}\right) + 25\ S$$

where C, H, O, and S represent the percentages of carbon, hydrogen, oxygen, and sulphur in the fuel. One cubic meter of CO, CO_2, or CH_4 contains 536 grams of carbon, and 1 cu. m. of C_2H_4 contains 1,071 grams of carbon. All the calculations as to calorific power are also based on the standard temperature and pressure of 0° C. and 760 mm., and all the steam derived from the combustion of the fuel or gas is treated as condensed.

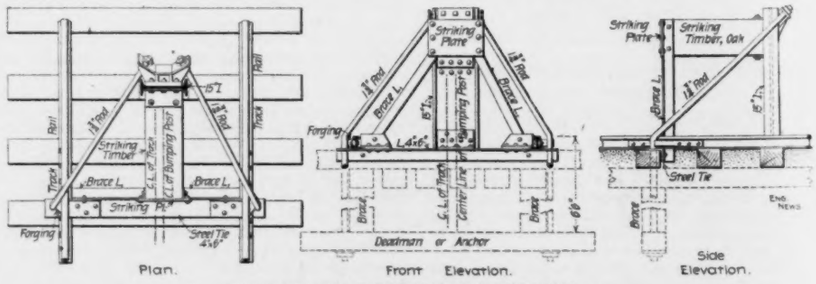
In these notes the author has discussed some of the theoretical and practical considerations which affect the working of gas plants used for engine work. He has also endeavored to collect the most trustworthy data obtainable, and in conclusion he thinks he cannot do better than quote the following remarks of Professor W., who is a recognized authority on all matters connected with gas power. He says: "The future of gas engines will depend to a great extent on the progress made with the production of generator gas; the question is to make this gas rich enough, to produce it in a simple way, to maintain uniformity of quality, and to keep down the working cost." Again, "There is a perfect relation between the calorific power of a gas and the mean pressure of the indicator diagram. . . . It would therefore be a mistake to try to make an apparatus produce much gas of poor quality; it would be better to work to a good average of about 1,300 calories. This conclusion is of great importance."

A NEW FORM OF BUMPING POST.

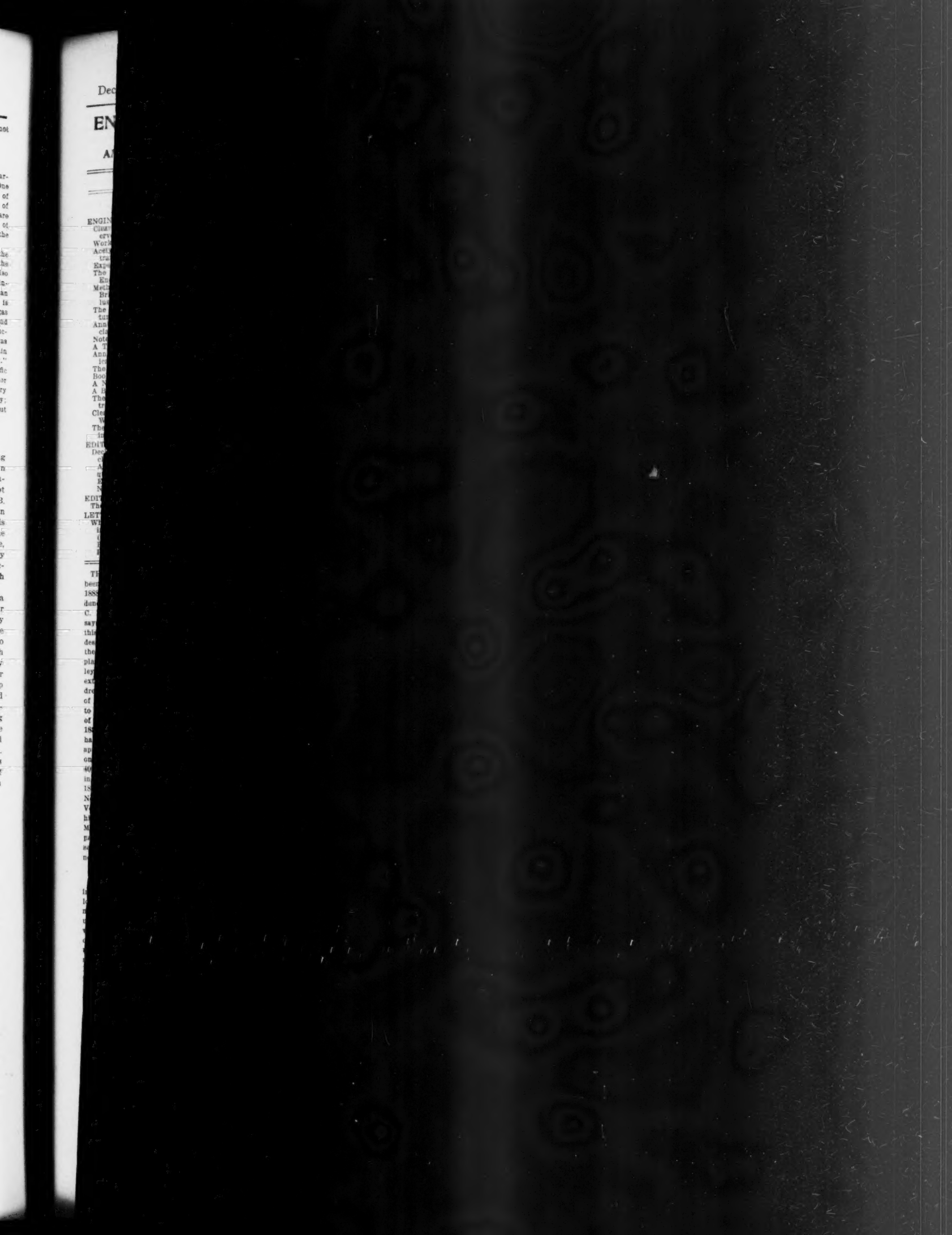
An addition to the numerous styles of bumping posts for the dead ends of railway tracks is shown in the accompanying illustration. The unique feature is that the center line of the post does not coincide with that of the track. In the M. C. B. coupler, the striking part of the head is not in the center line of the track and drawbar, but this fact has been almost universally overlooked in the design of bumping posts of the single-post type, with the result that when subjected to heavy usage they frequently become distorted, on account of the eccentricity of the blows to which they are subjected.

The post is a 15-in. steel I-beam, resting on a base plate ¾-in. thick, and supported by anchor rods 1¾ ins. diameter, with upset ends held by nuts on a heavy forging bolted to the top of the post. These rods extend forward and outward to clear the rails, and then pass vertically through a 4 × 6-in. angle iron crosstie, and an ordinary wooden tie, extending down to an anchor block or deadman buried in the ground 6½ ft. below the top of the rail. Vertical braces or spreaders are fitted between the anchor timber and a longitudinal timber under the ties, so as to prevent the loosening of the anchor rods when the post is struck. The rods are held in position against the rail by steel forgings bolted to the rail with 1-in. turned bolts.

An oak striking block, 12 × 12 ins., 3 ft. long, is bolted between angle iron brackets on the face of the post, its outer end being fitted with an iron striking plate and supported by angle iron braces, whose feet are connected to the steel tie by riveted connections. These braces prevent lateral deflection of the timber when struck. With the exception of the striking timber all the parts are of metal, and as the riveting is done at the shops there is very little field work required in the erection of the post.



BUMPING POST FOR RAILWAY TRACKS.
J. B. Cox, Chief Engineer, Chicago Junction Ry., Chicago, Ill., Inventor.

This bumping post has been invented and patented by Mr. J. B. Cox, Chief Engineer of the Chicago Junction Ry., Chicago, Ill., and we are indebted to him for blue prints and other information.

[1] In all the trials of this plant, 2% of the fuel has been treated as lost with the ashes, except where this loss was known definitely.
[2] Minutes of Proceedings Inst. C. E., vol. cxxix. p. 191.
[3] "Gas, Oil, and Air Engines," p. 238.
[4] Minutes of Proceedings Inst. C. E., vol. cxxix, p. 190.
[5] To express calories per kilogram in B. T. U. per pound, multiply by 1.8.
[6] "Moteurs à Gaz," vol. ii. p. 89, and vol. iii. p. 186.